JPRS-USP-94-001
16 February 1994


# JPRS Report

# Science & Technology

## Central Eurasia: Space

# Science & Technology
## Central Eurasia: Space

JPRS-USP-94-001 16 February 1994

CONTENTS

## SPACE ENGINEERING



## SPACE APPLICATIONS



## SPACE POLICY, ADMINISTRATION

## Crew Members, Aims of New Mission to Mir Station

*947Q0053A Moscow KRASNAYA ZVEZDA in Russian 6 Jan 94 p 3*

[Article by Valeriy Baberdin, KRASNAYA ZVEZDA correspondent: "Extending One's Hand From the Mir to Mars; The Next Space Expedition Leaves in January. It Includes a Physician Who Will Spend a Record Time in the Station: 427 Days"]

[Text] The principal hero of the experiment is cosmonaut-researcher Valeriy Polyakov, deputy director of the Biomedical Problems Institute, candidate of medical sciences. He already has been in the orbital station. He worked there for 241 days with Aleksandr Volkov and Sergey Krikalev.

"Yes, we need this flight primarily as a record," states Polyakov. "It is impossible for us to let go of our first-place standings with ease. In addition, it will afford us the opportunity for the first time to rehearse the medical support for what in essence is an expedition to Mars."

"But a record time is not an objective in itself. The flight will be saturated to the limit with an interesting scientific program. It will enable us to rise to a new level in understanding all that which transpires in the human body in space. The project has been supported by all those countries of Western Europe whose astronauts have flown in the Mir and which are actively participating in realization of the new flight."

"Valeriy and I will set to work," says Colonel Viktor Afanasyev, the crew commander, joining into the conversation. We calculated: the crew literally each day will participate in medical research. The active work of a physician will determine the character not only of our expedition, but two others as well which it will meet and live with in orbit. But we also have planned other experiments: in the fields of material science, bioengineering and astronomy.

Viktor Afanasyev also is no novice in space. When he went before the interdepartmental state commission for admission to special training he was scheduled for flight under the Buran program. Then he was transferred to the group of pilots for spaceships of the Soyuz-TM series. He made his first flight in the Mir station together with Musa Manarov in 1990-1991.

The ship's engineer, Yuriy Usachev, is the youngest in the crew and perhaps the youngest among those who are today preparing for flights under different programs. To my question as to how he feels psychologically prior to the launch, whether he is ready, he became thoughtful:

"I do not know what to say. It is probably necessary to sit first in the ship, enter orbit and work for at least a half-year in the station, and so it is possible to philosophize for a long time. I will go with quite experienced cosmonauts and I would not want to feel myself such a schoolboy. During the time of the expedition I will strive to 'get educated,' to better study all the systems and equipment on the station. It is necessary to fly more than once."

At any rate, we wish good success to the cosmonauts.

## Regression Approach to Calculated Absolute Calibration of Satellite-Borne IR Radiometers

*947Q0072 Moscow IZVESTIYA AKADEMII NAUK FIZIKA ATMOSFERY I OKEANA in Russian Vol 29, No 5, Sep-Oct 93 pp 634-638*

[Article by V. P. Kozlov, Yu. M. Timofeyev, A. V. Polyakov, St. Petersburg State University; UDC 551.510.5]

[Abstract] Most satellite IR radiometers used for remote sensing of the atmosphere and the underlying layer have systems of onboard absolute calibration of measurements of outgoing radiation. For various reasons, however, the instruments must be calibrated independently for the different periods of their operation. As a rule, such calibration consists of calculations of the absolute values of the intensity of outgoing radiation on the basis of the use of modern radiation models of the atmosphere, information on the physical and optical state of the atmosphere and the underlying layer in the areas of calibration, and the spectral characteristics of the radiometers. There are inherent difficulties in objectively assessing the accuracy of such calibration and in factoring various kinds of information into the calibration algorithms. The researchers here use the statistical regression method in the calibration, guaranteeing the smallest rms error of prediction and making it easy to consider arbitrary sets of controlled variables and arbitrary measurement modes. An adequate radiation model for statistical modeling of emission variations is used for given variations of parameters of an optical-meteorological model of the atmosphere. The radiation model (an integral equation of thermal emission transfer) is linearized in the vicinity of some standard atmospheric state satisfying the average climatic or seasonal conditions for a given region. References 7: 3 Russian, 4 Western.

## Russian To Launch Israel's TAUVEX Ultraviolet Telescope in 1995

*947Q0070 Moscow NEZAVISIMAYA GAZETA in Russian 18 Jan 94 p 6*

[Article by Sharon Kenon, JerusalemInform, under the rubric "Astronomy": "The Ultraviolet Universe: Space Telescope Studies New Stars"]

[Text] A new space-based ultraviolet telescope designed and built in Israel will make it possible to penetrate the mysteries of the universe. That telescope—the result of the joint efforts of Tel-Aviv University, the Israeli Space Agency, and the firm ELOP—will be the "all-seeing eye" of a spacecraft that will be launched in 1995. Israel has received permission to participate in an international project involving the first science mission for the study of celestial objects in the ultraviolet range of the spectrum.

"We have all the necessary basic infrastructure for space technologies," said Ethan Reys (Eytan Reys), the head of the space developments division of the firm ELOP.

The TAUVEX telescope (TAUVEX stands for Tel-Aviv University UV Explorer) was developed to fill the considerable gap in our knowledge of the universe. Astronomers have successfully observed stars in a broad range of the electromagnetic spectrum, to include the visible, radio, x-ray, and infrared ranges of the spectrum. The ultraviolet range, however, remains accessible in only individual fragments.

"It is impossible to perform sufficiently precise observations in the UV spectrum from the ground, because of the severe scattering of UV radiation in the atmosphere," said Reys. "The only way to get images of distant or weak stars is to take the science instrumentation into space."

TAUVEX will be pointed at "white dwarfs" (new stars that emit high-energy UV radiation), binaries (binary stars), galaxies, and quasars (extremely bright objects at the edge of the universe). "We expect the search for quasars to be more productive than any other search every undertaken," said Dr. N. Brosh, an astronomer at the Weiss [Vays] Observatory of Tel-Aviv University. That observatory is the most active observatory in the Eastern Mediterranean. "We expect to catalog more than 10,000 new quasars, which will be identified from their UV spectra. At present, only about 4,000 quasars are known from ground-based observations."

The information that will be obtained in the course of the mission will help scientists to have a better understanding of the physical nature of high-energy sources such as neutron stars and black holes. Using the broad-range UV telescope, scientists will have a unique opportunity to get to the heart of the process associated with the formation of stars and to ascertain their makeup, velocity, size, age, emittance, and position. All that information not only expands our knowledge of the current state of stars, their origin, and history, but will also help to predict their future.

The images will be obtained with three telescopes: two of them designed for scientific research, and the third serving as a position and velocity sensor for the spacecraft itself. Those data are very important in that producing images requires lengthy exposures. "The data of the third telescope will make it possible to reconstruct images that are blurry because of the long exposure while the spacecraft is moving. The information on direction and velocity makes it possible to produce images as if from an immobile platform," said Reys.

The spacecraft will be launched into an elliptical orbit with a maximum distance from Earth of 200,000 km and a revolution period of three days. Low-orbit satellites usually complete a revolution in an hour and a half. The satellite will function in orbit for three years.

One other unique feature of the TAUVEX system is that it provides a field of view that is 500 times greater than the field of view of the wide-angle camera of the Hubble Space Telescope.

The satellite is to be launched from the CIS. The data will be received at sites in Russia, but will be made accessible to all scientists participating in the project.

### Optimization of Perturbation Maneuver of Solar-Sail-Equipped Spacecraft Near the Moon in a Geocentric Boost Problem

*937Q0064A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31 No 6, Nov-Dec 93 pp 31-38*

[Article by V. V. Smirnov, V. A. Yegorov, V. V. Sazonov; UDC 629.7]

[Abstract] In work reported earlier (Smirnov et al., "Geocentric Boost Trajectory for Spacecraft With Solar Sail," KOSMICH. ISSLED., 1993, Vol 31, No 3, pp 74-90), the researchers here studied boost trajectories that took spacecraft from low geocentric orbit to outside the Earth's sphere of influence. Trajectories with the fastest boost included a perturbation maneuver near the Moon and consisted of three legs, the first and the third using a locally optimal principle for controlling the sail, and the second being a passive leg. The times for the beginning and end of the passive leg are chosen such that they ensure swingby of the Moon and optimize the perturbation maneuver. The modulus for the geocentric velocity of the spacecraft after swingby must be maximized. During the swingby, if the angle between the planes of orbit of the spacecraft and the Moon is large, then the spacecraft can be sent to any point of the rather small environs of the Moon on the picture plane via selection of the beginning and ending times of the passive leg. If the angle is 2-20°, however, the small environs of the Moon in the picture plane may be unreachable, which limits the possibilities of a perturbation maneuver. In the earlier work, to expand the perturbation maneuver possibilities, the researchers suggested reducing the angle to less than 1° by making a minor correction in the locally optimal principle of control in the first and third boost legs. Here, they suggest a different method for optimizing the perturbation maneuver, i.e., inserting an additional leg just before swingby. In the new leg, the locally optimal control is replaced by optimal control that maximizes the geocentric boost of the spacecraft after swingby. The length of the new leg is the problem parameter. If the length is large, the efficiency of the maneuver is increased considerably and total boost time is reduced somewhat. Figures 1, references 9 (Russian).

### Model of Particle Fluxes and Averaged Energy Spectra of Solar Cosmic Rays

*937Q0064B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31 No 6, Nov-Dec 93 pp 51-59*

[Article by R. A. Nymmik; UDC 543.42:522.124]

[Abstract] The high-energy charged-particle fluxes that accompany solar flares are a focus of study because of their effect on biological objects and hardware during spaceflight. The danger associated with such events depends on the frequency of the events, the magnitude of the flux, and particle energy spectrum. Based on acquired experimental data, solar cosmic ray events are classified here by magnitude of total proton fluence. At proton energies of more than 30 MeV, power-law functions of particle rigidity serve well to describe the averaged energy spectra of peak proton fluxes and proton fluences that characterize solar cosmic ray events of varying magnitude. Average energy events become steadily more rigid as event fluence magnitude grows, and average magnitudes of peak flux remain proportional to fluence across the entire range of fluence variation. The averaged energy spectra of anomalously large and very large events do not contain anomalies in terms of probability of occurrence or type of energy spectrum. The average energy spectra of solar cosmic ray events differ from those of CREME in that they establish the presence of rather large, high-energy particle fluxes in the solar cosmic events. Such particle penetrate spacecraft shields, or, after passing through the Earth's magnetic field, they penetrate to lower geomagnetic latitudes in the Earth's atmosphere and to the near-Earth orbits of satellites with small inclinations. Figures 7, references 15: 3 Russian, 12 Western.

### Forecasting Radiation Conditions in Interplanetary Space

*937Q0064C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31 No 6, Nov-Dec 93 pp 89-103*

[Article by B. M. Kuzhevskiy, V. M. Petrov, I. P. Shestopalov; UDC 581.521]

[Abstract] Sources of radiation in interplanetary space are essentially three: galactic cosmic rays, solar-flare cosmic rays, and recurrent fluxes of low-energy particles from the Sun. The most dangerous of the three are solar-flare cosmic rays, on which there exists the smallest volume of data. Forecast methods associated with a search for flare precursors in the optical, radio, and x-ray ranges are unreliable in predicting solar proton events. The work reported here is a continuation of earlier work by Shestopalov et al. in which the researchers demonstrated that proton flares arise in the course of processes that encompass not only various layers of the solar surface, but also interplanetary space. Moving a step farther, the researchers here show that the preflare period involves not only changes on the Sun and in interplanetary space, but also a disturbance of the Earth's magnetosphere and magnetic field and a generation of particles in near-Earth space. Active regions are observed on the Sun during the period, as are coronal formations and their ejection into interplanetary space. Large proton- and electron-filled ordered magnetic structures appear in interplanetary space, and the flux of galactic cosmic rays diminishes. On Earth, magnetic activity increases, causing in turn an increase in the amplitudes of magnetic storms in those areas. In addition, magnetospheric protons with energies of 40 MeV or

greater are recorded in interplanetary space. Figures 5, references 15: 13 Russian, 2 Western.

### Depth Profiles of Dielectric Permeability of Cryolithosphere of Mars

*937Q0063A Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 27 No 6, Nov-Dec 93 pp 3-11*

[Article by V. A. Andrianov, I. N. Kibardina, R. O. Kuzmin, Institute of Radio Engineering and Electronics, Russian Academy of Sciences; Institute of Geochemistry and Analytical Chemistry imeni V. I. Vernadskiy, Russian Academy of Sciences; UDC 523.43-834]

[Abstract] One of the principal objectives associated with the study of the Martial surface in the Mars-94 mission will involve study of the cryolithosphere of the planet and its depth structure. An orbiting vehicle will probe the surface with radar in the frequency range of 0.5-5 MHz with the emission of pulsed radio signals and measurement of the strength of the signals reflected off the nightside surface. Interpretation of the signals will be unusual in that the cryolithosphere is a multicomponent medium with a nonuniform structure that results from, among other things, considerable depth variation in ice content and the possible presence of saline ice and briny solutions. In light of that, the work reported here involves a technique for calculating the depth profiles of the dielectric permeability of the mixtures of the various materials in the cryolithosphere based on the temperature and frequency relationships of the dielectric permeability of ice. The technique assumes that the frozen ground can contain either freshwater ice or saline ice, and it enables calculation of the dielectric permeability of two- and three-phase ellipsoidal-particles mixtures, depending on the volumetric content of the soil components and their dielectric permeability. The dielectric permeability of ice is calculated in the context of the theory of orientation polarization of dielectrics with typical relaxation times. The researchers concluded that the skin layer may be hundreds or thousands of meters thick, depending on the soil composition. Figures 4, references 13: 6 Russian, 7 Western.

### Qualitative Analysis of Some Methods of Reducing the Asteroid Hazards for the Earth

*937Q0063B Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 27 No 6, Nov-Dec 93 pp 46-54*

[Article by V. V. Ivashkin, V. V. Smirnov, Institute of Applied Mathematics imeni M. V. Keldysh, Russian Academy of Sciences; UDC 629]

[Abstract] The probability of a collision between the Earth and an asteroid such as Amor, Apollo, or Aton is not at all small. The work reported here consists of the results of a preliminary analysis of the use of various methods for preventing such a collision, all of which involve changing the asteroid's orbit: space vehicle impact; delivery and attachment of a large-thrust engine to the asteroid; attachment of low-thrust electroreactive engines; attachment of a solar sail; and changing the color (thus, the reflective properties) of the asteroid's surface. Prevention of the collision is considered to be guaranteed if the flyby distance is at least 1 million kilometers. The asteroid, in the calculations, is taken to be a sphere with a density of 3 g/cm$^3$. Estimates are made for asteroids with radii of 5 m, 50 m, and 500 m and masses of 1.57 x 10$^6$ tons and 1.57 x 10$^9$ tons. After a comparative analysis of the methods, the researchers chose the impact method as the most effective method and a method that could be performed with existing technology. Numerical estimates are given for the asteroid Toutatis, which flew by Earth in December 1992. The work was performed in the context of an agreement with the International Institute of Problems of Asteroid Hazards under the Toutatis-B2 grant. Figures 2, references 4 (Russian).

### Origin and Current Status of the Problem of Asteroid Hazard

*937Q0063C Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 27 No 6, Nov-Dec 93 pp 55-68*

[Article by F. A. Tsitsin, V. M. Chepurova, I. L. Genkin, State Astronomy Institute imeni P. K. Shternberg; Kazakh State University imeni al Farabi; UDC 523.4-523.62-726]

[Abstract] In a survey of the history and background of "asteroid hazard," the researchers here define such danger as the threat of collision with Drobyshevskiy cometoids or comet-shower comets from Oort's Cloud, asteroids near the Earth (primarily of cometary origin), asteroids with chaotic orbits, and short-period comets. We are, they conclude, in a period of minimal cometary activity and asteroid hazard because the last cometary shower caused by disturbance of the cometary cloud ended long ago, and the next such event will not occur for at least 10 million years. Nor are there at present any objects near the Sun that could cause such a shower. Finally, the unexpected and unpredictable cometoid activity described by Drobyshevskiy and resulting from an explosion of the Jovian moon Callisto is virtually impossible. At the same time, the statistically unpredictable fluctuation in asteroid hazard dictate that we refine our theoretical research of the problem and set up observation programs. The objective of the first stage of such research would be to move asteroid collisions from the ranks of random, unpredictable phenomena to the ranks of predictable, calculable events. References 17: 13 Russian, 4 Western.

### History, Present Significance of Kapustin Yar Cosmodrome Discussed

*937Q0032 Moscow KOMSOMOLSKAYA PRAVDA in Russian 26 Nov 93 p 3*

[Article by Igor Yemelyanov: "This Yar Wasn't So Easy to Come By: Our First Space Launch Facility Hears the Roar of Rockets Less and Less Often"]

[Text] When the United States got its hands on the German V-2s in '45, it was soaring high in the sky. The USSR managed to get only the crumbs from the German rocket pie, but we had S. Korolev and V. Glushko and the pride of the victors.

On October 18 of '47, the first Soviet rocket, the R-1, flew its first 207 km. It launched from the top-secret testing grounds of Kapustin Yar. Out of 10 proposed sites strewn across the Union, a piece of the Volga steppe the size of a small European state was chosen. They say that Lawrence Berry [Lavrentiy Beriya] himself kept tabs on the project.

They didn't allot much time to hammer out the country's missile shield, throwing three engineering-construction brigades from the front to Kapustin Yar. V. Voznyuk, the katyusha specialist who had rocketed from major to general in one year of the war, created a super testing ground on the barren spot at Stalin's command. The railroad to it from Stalingrad didn't go through a single population center.

The military watch began with the R-2, the absolute favorite of the testers for the 6 tons of alcohol that went in to make up the fuel. The R-5 was the first missile with a nuclear warhead to rush to the east. They say there that, to this day, no one knows whether it exploded or not, or where it could have happened. The famous R-12s, which were hauled to Cuba in order to settle the Caribbean crisis, stood "cocked" for a full 30 years and were regarded as the strongest of the fingers of our nuclear fist. True, the alcohol in them was long gone, but the parity with the Yankees wasn't shaken. The RSD-10 (SS-20), which was born in '73 and shocked all our enemies, had no match for many years. When the United States got wind of them, it decided right then and there to make peace with the "evil empire."

The road was carved out for Gagarin by 48 dogs launched from Kapustin Yar. The first to go aloft, in the summer of '51, were not Belka and Strelka, who were also prepared here, but Dozik and Tsygan. Later one pioneer died, and a second lived with S. Korolev's family. A dog by the name of Otvazhnaya [Brave] went up four times. But not all of them were drawn to the stars—one animal decided to run away just before the launch, right from the launch pad, and they had to send the nearest mongrel up into space in its place. But it didn't matter, they got the job done for the party and the government.

At Kapustin Yar, they built the first artificial Earth satellite, which was put into orbit from Baykonur. At Kapustin Yar, they worked the bugs out of the space television, radio, and telephone communications.

The heaviest fog of secrecy had barely lifted in '73, when we helped the Poles lift their first, the Copernicus-500, to the proper altitude. We launched the friendly Indian Ariabata series in '75, and after that, even the French were allowed to go to orbit from there.

Buran, which engendered a flurry of enthusiasm when it took off and landed in Kazakhstan, was painstakingly built in the Volga region under the supervision of German Titov.

But in the '80s, we got "caught up," as it were, in big space. The USSR had another space jacket—Baykonur

Hit over the Urals on the first of May in '60, the American pilot Powers had been quite [illegible] as he bailed out of the cozy U-2. His superiors had not warned him that the Russians had the Volkhov S-75 antiaircraft missile complex, which laughed at the high-altitude jet capabilities of the reconnaissance plane from the States. They didn't warn him because they didn't know the Russian had it.

The antiaircraft testing grounds had broken away from its strategic missile brother in '51, and within less than two months, it roared with the first vertical-launch surface-to-air missile. The multichannel creation was outfitted to protect the motherland's capital. Within three years, the surface-to-air missile complex was firing at 20 targets at once. In May of '55, first Moscow, and then other important centers and borders were bristling with the arrows of SAMs.

The first mobile SAM unit, the Dvina, was combat ready in late '57, near Brest. A version of it, the Volkhov, not only interrupted the spy flight over the center of the Soviet military-industrial complex, but also let the United States know that the USSR was ahead of everyone else on the planet in air defense, which meant that it was hazardous to flit about perniciously over one-sixth of the land surface.

The Volkhov, and later the Pechora, made their way to 40 countries and didn't do badly in the confrontation with Phantoms in Viet Nam and Mirages in the Near East.

In just two years at Kapustin Yar, they "rolled out" the first automatic system for controlling SAMs. The mid-60s saw the appearance of radar systems for detecting enemy aircraft. Finally, unique simulator systems were created in the '70s. That is, by turning on a computer, but without launching aircraft or rockets, they were able to work out the bugs there in combat with any air attack that might happen. The Americans were gnashing their teeth with envy. And in February of '93, all they could do was hold on to a pillar in Abu Dabi: in the Arabian sky, Russian-made S-300s on the fly knocked out two cruise missiles. The sheiks gave a standing ovation.

Do you remember the story about the "submarine in the Ukrainian steppes?" It's not altogether a myth. In Kapustin Yar, in an immense basin, is a sub in which they used to test sea-launched missiles. Generally speaking, Kapustin Yar is replete with legends. The burst of myth-making began between '88 and '91, when 654 intermediate-range SS-20 missiles were being destroyed here.

Legend No. 1: nuclear explosions occur in the Volga steppes. In fact, the warheads have been removed in other places, and here they've only exploded batches of airframes.

Legend No. 2: as a result of the explosions in Kapustin Yar, windows have shattered, walls have cracked, and, in Volgograd, homes have been demolished. On August 30 of '90, Academician Ye. Velikhov reported in an analysis that the seismic vibrations 5 kilometers from the explosion site do not exceed 3 on the scale. It's 28 kilometers to Kapustin Yar, the windows in the local department store shattered only once, when a fighter plane broke the sound barrier over the city.

Legend No. 3: a massive die-off of sheep was associated with the missiles. A commission of the main directorate, veterinarians, and a scientific research institute found sulfur and arsenic in the wool and livers of the sheep that died. The lab head from the All-Union Scientific Research Institute, G. Kashfutdinov, suggested that "the main reason for the deaths was, apparently, the rocket-fuel combustion products of unknown composition." We could brand the fleecing missile-people, but the "rocket fuel products" of the SS-20 contain neither sulfur, nor arsenic; the emissions of the Astrakhan Gas-Condensate Combine, however, does contain those products.

The keys to the Kapustin Yar, a city of 32,000 closed off by three checkpoints, are held in two hands—that of the garrison leadership and that of the city government. And although the small Astrakhan Oblast Council pointed out on May 17 of this year that, according to current law, the civilian executive body is supposed to reign in Kapustin Yar, the real boss of that settlement is Gen. V. Tonkikh.

But that doesn't mean that the missile arm of authority and the civilian arm of authority are locked in battle under the carpet. Last April, the local police, together with the military, averted a massive action of youth that was meant to "run out of town" Kavkaz people who had been attracted to Kapustin Yar to revive trade. It was averted without any injuries. Over all of '93, there was only one murder.

The initial impression that it's mainly sports figures and top models who live there was confirmed in a visit I made to the sports complex, which has a pool, a shooting range, and a stadium.

Today, the leasing of launch pads in Kazakhstan, which may be seeing their last winter, costs billions, and their equipment and people can and should be transferred to a re-outfitted Kapustin Yar, where products and fuel don't have to be brought in by plane.

And if Plesetsk, planted in the northern bogs, can be regarded as the Russian equivalent to the Kapustin Yar missile testing grounds, then the air-defense testing grounds in Zavolzhye is the only one in Russia. We no other sites where we can do a professional job of testing antiaircraft systems that tomorrow would protect both the country and its interests in local conflicts. Where else is it possible to be demonstrating to hard-currency buyers, on a permanent basis, new SAM complexes in all their glory (China has already bought a batch of S-300s, Kuwait is thing about it, although what's there to think about—the Patriots are more expensive and not as good)? In the opinion of V. Korolev, the deputy chief for science of the air-defense testing grounds, any and all kinds of weapons from any of the combat arms could be tested in Kapustin Yar.

Whatever the military doctrine, it would be stupid to not preserve the Kapustin Yar testing grounds after having made them into a base for the country's armed forces and having abandoned expensive foreign launch pads.

## Probability of Asteroids Colliding With Earth

*937Q0061 Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 27 No 5, Sep-Oct 93 pp 83-87*

[Article by A. F. Zausayev, A. N. Pushkarev, Institute of Astrophysics, Academy of Sciences of the Republic of Tajikistan; UDC 521.1]

[Abstract] In studying the danger of asteroid collisions with Earth, one must identify the objects whose orbits will intersect with that of Earth. At present, those objects comprise asteroids of the Apollo, Amor, and Aten groups; asteroids of the X group; short-period comets; and large fragments of meteor trails. This paper examines only asteroids of the Apollo, Amor, and Aten groups, primarily because we have precise data describing their orbits. It focuses on 114 asteroids. The researchers perform numerical integration of the equations of motion of those objects via a method advanced by Everhart. Orbital elements were calculated, as were minimum distances under 0.05 au between the asteroids and Earth. A total of 89 of the asteroids were found to be candidates for a collision. The line of apsides of the asteroids has a rotational-translational motion, completing a full revolution over a period of tens of thousands to hundreds of thousands of years. Over a period of a full revolution, the asteroid orbit can intersect with that of Earth at four points. The researchers computed the mathematical probability τ of such an event as a function of asteroid velocity and orbital inclination and then calculated the time period in which the asteroid could collide with Earth. Although it could take 6·10 million years before an asteroid could collide, the overall danger of collision is considerably greater than is the danger associated with one asteroid, mainly because there may be many asteroid still undiscovered. References 8: 6 Russian, 2 Western.

## Control of Flight to Halo Orbit in the Vicinity of the $L_2$ Point (Relict-2 Mission)

*937Q0060 Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 19 No 9, Sep 93 pp 868-880*

[Article by M. L. Lidov, V. A. Lyakhov, N. M. Teslenko, Institute of Applied Mathematics, Russian Academy of Sciences, Moscow; UDC 521.1]

[Abstract] Trajectory designs have traditionally involved a single-stage, one-impulse flight to halo orbit near libration points $L_1$ and $L_2$ of the Sun-Earth system. Launch parameters were chosen so that after boost near Earth, the spacecraft would enter a trajectory passing rather close to the libration points, with halo orbit C = 0. Other researchers have proposed designs that reduce the orbit-size parameters, with a rendezvous with the Moon not immediately after launch, but after a given number of revolutions in a highly elliptical orbit whose perigee is near the Earth and whose apogee distance is greater than the radius of the lunar orbit. The researchers here study the possible use of such a trajectory to perform the Relict-2 mission in the context of the constraints on the control system that is to be used in the mission. Analysis shows that a design with two revolutions in intermediate orbit is best for trajectories involving a lunar swing-by. The maximum size of the halo orbit for an October launch would be 250,000-310,000 km; for a November launch, 180,000-220,000 km. Height of perigee for the first launch date would be less than 320 km; for the November launch, lower than 300 km. The spacecraft would probably not be in the Earth's shadow for the first year. Figures 2, references 5: 3 Russian, 2 Western.

## Description of Control Associated With Placement of Spacecraft in Vicinity of $L_2$ Point of Sun-Earth System Via Use of Lunar Gravity (Relict-2 Mission)

*937Q0059A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31 No 5, Sep-Oct 93 pp 3-20*

[Article by M. L. Lidov, V. A. Lyakhova, N. M. Teslenko; UDC 629.197.23]

[Abstract] Until recently, trajectory designs have involved a single-stage, one-impulse flight to halo orbit near libration points $L_1$ and $L_2$ of the Sun-Earth system. Launch parameters were chosen so that after boost near Earth, the spacecraft would enter a trajectory passing rather close to the libration points, with halo orbit C = 0. Farquhar has proposed a design that reduces the orbit-size parameters ("Halo-Orbit and Lunar Swing-by Missions of the 1990's," 41st Congress of the IAF, October 1990, Germany) and that recommends a rendezvous with the Moon not immediately after launch, but after a given number of revolutions in a highly elliptical orbit whose perigee is near the Earth and whose apogee distance is greater than the radius of the lunar orbit. There is yet to be any published data, however, on the possible use of such a trajectory to perform the Relict-2 mission in the context of the constraints on the control system that is to be used in the mission. Analysis shows that a design with two revolutions in intermediate orbit is best for trajectories involving a lunar swing-by. The researchers here analyze the control characteristics for only the segment before lunar rendezvous. Their analysis considers launch errors, as well as measurement and correction-execution errors. Fuel expenditure at the velocity typical for performing control during entry into halo orbit is the principal criterion for quality of control. Control parameters are calculated for flight trajectories based on launches in October and November 1994. Figures 4, references 5: 3 Russian, 2 Western.

## Optimal Spatial Transfer of a Spacecraft Between the Lunar Surface and Artificial Lunar Satellite Orbit

*937Q0059B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31 No 5, Sep-Oct 93 pp 34-52*

[Article by K. G. Grigoryev, Ye. V. Zapletina, M. P. Zapletin; UDC 629.195.3]

[Abstract] In earlier works, the researchers examined optimal transfers between the lunar surface and lunar orbit for a spacecraft with a rocket engine of high, but limited thrust, with landing and liftoff sites not fixed. Those studies focused on fastest transfer, as well as transfer with a minimum value for the compromise functional of time-mass expenditure. The transfers were set in a central Newtonian gravitation field in the plane of orbit of an artificial lunar satellite, with thrust vector controlled. This paper builds on the earlier work, but involves the spatial characteristics of the transfer of the same spacecraft in the same lunar context. The researchers discuss the numerical solution of boundary value problems for 13th and 14th-order systems of the usual nonlinear differential equations that appear when the solution of the problems of optimal control of motion of the center of mass of the spacecraft is based on the maximum principle. In the current context, solution that involves shooting requires selection of 4-6 unknown initial conditions. Figures 5, references 33 (Russian).

## Optical Emissions of Pulsed Cosmic Source of 1 keV X-ray Beam

*937Q0059C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31 No 5, Sep-Oct 93 pp 78-83*

[Article by K. S. Mozgov; UDC 523.165;538.561; 551.593]

[Abstract] A great deal of practical value attaches to the study of the propagation in the Earth's atmosphere of x-ray emissions from deep-space nuclear explosions and the secondary physical phenomena produced by such explosions. This paper examines the possibility of ground-based recording of uneven light emissions excited in the Earth's atmosphere by an x-ray beam whose parameters are typical of an x-ray laser with pumping from a nuclear explosion. Since uneven light emissions in the atmosphere are isotropic, they can be

recorded at great distances from the beam axis. The researchers here examine the process associated with the light signal generation and calculate the amplitude-time characteristics of a light signal that comes about when an x-ray beam from a cosmic source interacts with the atmosphere. The light emissions achieve maximum intensity within $10^{-6}$-$10^{-5}$ sec. That time is a function of the position of the recording site: the farther the site is from the beam, the greater the time. Pulse width is also a function of recording-site position: the closer the site is to the beam, the faster the intensity grows ($10^{-5}$-$10^{-4}$ sec). Figures 2, references 18: 11 Russian, 7 Western.

## Space-Time Correlation Between Earthquakes and Variations in High-Energy Particle Flux in the Inner Radiation Belt

*937Q0059D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31 No 5, Sep-Oct 93 pp 84-90*

[Article by V. P. Pustovetov, A. B. Malyshev; UDC 523.037:525.7]

[Abstract] The search for phenomena tying anomalous variations in certain physical characteristics of near-Earth space to geoseismic activity has, to some extent, been successful in that satellite studies have uncovered anomalous low-frequency electromagnetic radiation in the upper ionosphere over the epicenters of earthquakes just before the ground activity begins. The source of the radiation is believed to be a ULF/ELF wave generated by seismoelectric transformations in the earthquake focus. The considerable spread of the parameters of the anomalous radiation in near-Earth space and the episodic nature of the phenomenon point to the variety and ambiguity of the generation and propagation of the seimoelectromagnetic radiation. The movement of such radiation into the ionosphere and the magnetosphere could cause variations in certain physical characteristics of charge particles of near-Earth plasma. Such has been the conclusion of research that studied the relationship between short-term sporadic deviations in the flux of high-energy particles trapped by the geomagnetic field and geoseismic activity. Analysis of the relationship between number of earthquakes and difference between the time of main shock and time of deviation of particle flux has produced a figure of $\delta t$ as approximately 2.5 hours. The researchers here set out to either confirm that finding or refute it by examining data obtained for the period of 16 June to 16 July 1990. They studied variations preceding the lithospheric earthquakes by 1-5 hours and focused near the L parameter corresponding to a projection of the earthquake coordinates to an altitude of 100 km. Sixty-four percent of the earthquakes occurring within the stated time frame were in a region whose center had the coordinates of 37°N lat, 49.5°E long. The researchers confirmed a space-time correlation between earthquakes with a magnitude of 3 or greater and the anomalous variation. Figures 3, references 13: 11 Russian, 2 Western.

## Effect of Fractal Geometry of Spatial Distribution of Radiating Electrons on Spectrum of Cosmic Radio Emissions

*937Q0056 Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 70 No 5, Sep-Oct 93 pp 1120-1122*

[Article by M. D. Noskov, Tomsk State University; UDC 524.7-77]

[Abstract] According to radio astronomy data, many cosmic radiation sources have a spectrum in which $F(\nu)$ is proportional to $\nu^{-\alpha}$ in the frequency range of $10^6$-$10^9$ Hz, with $F(\nu)$ representing the radiation intensity. The spectral value of the radiation, $\alpha$, is usually 0.5-1. Its distribution is gaussian, with a mean value of 0.75 and a standard deviation of 0.15. Since that type of spectrum cannot be attributed to thermal radiation, the nonequilibrium cosmic radiation is generally described with a synchrotron model. Particle polarization and the spatial coincidence between the system of cosmic magnetic fields and the sources of the nonequilibrium radiation point to the verity of such an approach. In proposing a new mechanism for the origin of the power-law spectrum of the cosmic radio emissions, the researcher demonstrates that, under the right conditions, the power-law spectrum can be a consequence of the fractal geometry of the spatial distribution of radiating relativistic electrons. Fractal dimensionality D of the distribution is related to spectral value with the formula $D = \alpha + 1/3$. As obtained from an analysis of observed values of the spectral values, the distribution was found to be 1.08 +/-0.15 in the range of 10-$10^3$ cm. References 10: 6 Russian, 4 Western.

## Measures To Deal With Problem of Space Debris Urged

*947Q0040A Moscow IZVESTIYA in Russian 11 Dec 93 First Edition p 15*

[Article by Kim Smirnov: "A General Cleanup of Space Must Begin"; the first paragraph is an introduction]

[Text] Who does not know the words from the "Little Prince" by Saint-Exupery: "He got up in the morning, washed up, put himself in order and immediately brought his planet into order! We know very well what must be done for the purity of the oceans, forests, cities and the atmosphere. We do a poor job of monitoring, to be sure. But it is not suspected that space also must be brought into order. Meanwhile the accumulation of space debris hides a danger which is in no way less dangerous than that from the 'ozone holes.' This was told to me by Lidiya Rykhlova, a department head at the Astronomical Institute, Russian Academy of Sciences."

Too frequently people concentrate on the lesser evil, not seeing that right here, alongside, a different and greater misfortune is taking shape. For example, how many now speak of the meteorite danger for cosmonauts! But now the Americans have carried out the following experiment: on a returned satellite they counted the number of

impacts from bodies of cosmic and artificial origin. There were far more of the latter. Scientists assert: the total mass of natural bodies in near space now does not exceed 200 kg. And that they and we have littered there about 3 million kilograms. So in actuality are cosmonauts threatened?

The first task of the new world space "service" is to monitor the unplanned falling of artificial space objects. But there also are other cases. The objects do not fall to the surface, but without warning explode in space and this may cause a precipitous increase in fragments on the "falling domino" principle.

For example, our Proton booster is one of the most reliable in the world. For this booster virtually all the shots into orbit have been "without a miss." But now it has been clarified at the conference on space debris: the last stage of the Proton, when after it has put a satellite into orbit, continues to "dangle" in space and after several years may explode. Six such cases were discovered. If it is taken into account that there already have been about 200 Proton launchings (and 6- 7 are still being planned annually), you can visualize how these "cleanest" rockets will increase the danger.

Now through the joint efforts of our and American specialists the reasons for the explosions seemingly have been clarified and will be eliminated. But in any case there also is one more common reason: attention has been concentrated on current launches and what will happen there after five years with the spent parts gives no one concern.

In this connection the problem acutely arises of stationary satellites, in particular, meteorological communication satellites. These are vehicles which are launched to such an altitude that at all times they hover over the very same point on the Earth, revolving together with it with the same angular velocity. Since the orbit of these satellites is unique and individual, a small "window" has been allocated to each country with an admissible deviation from it of only 74 km.

Upon exhausting its useful life, the satellite remains in this "small window." It would be good to have it removed from there in order not to hinder new launches. But this will cost as much as its operation for a month. When the dilemma arises of removing a satellite from orbit a month before exhaustion of its useful life or receiving valuable information for a month more, the latter choice is usually made. But, indeed, ever-newer satellites are being launched there.

True, there already have been precedents for more long-range solutions. Already in 1979 the Soviet Union removed the first such satellite from orbit. Some other countries took the same step. But in most cases stationary satellites remain in their orbits, concentrating into very small space "clusters."

Visualize that in this dense clustering of satellites there is an unplanned explosion of a spent vehicle. Indeed, already about 4500 satellites of different countries have accumulated in this orbit. Incidentally, there have already been such explosions, but up to this time we do not know how many fragments they have generated. Observations from the surface make it possible to see only fragments which are larger than a meter.

It is clear that observation methods and instruments must be improved. But something else also is clear: there must be strict international laws restricting and preventing space contamination, in this respect regulating both the launch of vehicles and their return to the Earth.

How to contend with space debris? It is possible to find a traditional way: by strengthening the skins of ships, their resistance to meteorites and the fragments of man-made vehicles. But it also is possible to decrease the number of launches without thereby reducing the amount of equipment put into orbit. Indeed, the principal component of space debris is cast-off rocket stages and the common task of all the space powers is "cleaning up" their technology in order that it be accompanied by the fewest parts so that fewer of them will be "dumped" in space. Unfortunately, for the time being there are no impressive projects for the cleanup of space anywhere in the world, perhaps this is in the imagination of science fiction writers. Mankind, as before, lives in this respect in accordance with the Russian proverb: "as long as the thunder does not burst forth, the peasant does not cross himself."

But the time for crossing oneself has long passed. For example, orbiting the Earth at a relatively low altitude there are 54 satellites with radioactive energy sources aboard. In principle it is assumed that when their active existence ceases there will be sufficient time for the nuclear fuel to "deactivate" to a safe level. But, indeed, here also there were unpredictable, unmonitorable accidents. Misfortune could be prevented through the common efforts of different countries. Incidentally, the last such case became the direct reason for the first meeting of space "cleaners" in Germany, at Darmstadt, in 1992.

The second conference of the International Coordinating Committee on Space Debris was held recently in Moscow. Absolutely new business and for the time being four organizations are participating in it: the Russian, European and Japanese Space Agencies and NASA. Working groups on observations, measurements, compilation of catalogues, research on the environmental impact, on tests and protection and on reducing contamination are already in operation. In short, the "reduction of space to order" has begun. For the time being work is for the most part with modeling. But the time is coming when in circumterrestrial space there will be gigantic vacuum cleaners, debris collection machines, debris containers and conductors.

Scientists and specialists are sounding the alarm. Even astronomers are complaining: space debris is hindering observations and more and more often it is being mistaken for meteorites and novae. But people throughout the world will sleep calmly, that is, until a manmade fragment crashes onto their heads.

## Russia's Position in World Aerospace Materials Market

*947Q0048A Moscow KOMMERSANT DAILY in Russian No 239, 11 Dec 93 p 8*

[Article by Sergey Morgachev and Igor Vershinin: "The World Market Is Interested in the 'Know-How' of Russian Aerospace Materials Science"; the first paragraph is an introduction; the last three paragraphs provide general information]

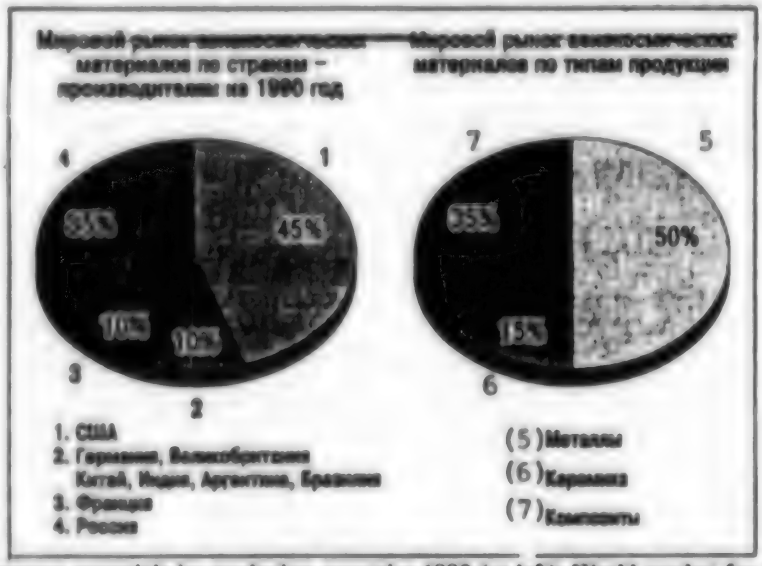
[Text] The development of new materials with stipulated properties is now considered throughout the world as one of the key directions in technological progress, comparable in importance information science and communication. The "leading edge" of this development work is intended for aviation and rocket-space machine building. Russian development firms have strong technological positions in this field, which enabled them relatively successfully to carry out the first stage of entry into the world market: about 20% of the financing of the programs is now accounted for by foreign contracts. The representatives of the leading Russian enterprises—NPO VIAM, NPO Kompozit and others—became frequent guests of Western colleagues: in particular, a delegation of the NPO VIAM during the past week held scheduled consultations with the Dassault Company and other French partners. Our reviewer Sergey Morgachev and our expert Igor Vershinin comment on the situation in this market.

### Results of Technological Race

Russian enterprises have a general advantage over Western competitors with respect to metallic materials for aerospace technology. In the case of ceramics one can speak in general of parity, although the relation of capabilities with respect to different types of materials is different. With respect to composite materials, the United States has the general advantage, although in this field as well some Russian developments are entirely competitive.

Specialists point out the leadership of Russian firms with respect to the strength and plastic qualities of alloys based on aluminum, molybdenum and niobium with their high melting points, as well as intermetallide compounds, and heat-resistant nickel alloys. The All- Russian Institute of Aviation Materials (NPO VIAM) stands out as the leading firm for conceptual development work, whereas experimental production is for the most part concentrated in the All-Russian Institute of Light Alloys (both in Moscow).

Nowhere in the world is there an equal to Russian heat- and erosion- resistant protective ceramic coverings based on silicon and zirconium compounds and heat-shielding ceramics based on quartz and carbon-carbon compounds. Many of these technologies were developed in their time within the framework of the Buran program. The principal enterprises working along these lines are the NPO VIAM and the NPO Tekhnologiya. The




**World market for aerospace materials by producing countries 1990 (at left); World market for aerospace materials by types of production (at right)**

Key: 1. United States 2. Germany, Great Britain, China, India, Argentina, Brazil 3. France 4. Russia 5. Metals 6. Ceramics 7. Composites

United States, on the other hand, leads the way in another key direction in work in the ceramics field: development of construction materials for engines.

Finally, Russian composite materials of the carbon-carbon and carbon- silicon carbide type, used for heat shielding of construction elements, are of equal quality to American products. The methods for producing these materials are technologically more feasible, simpler than the corresponding American methods. The key Russian firms working in this field are the NPO Kompozit and the State Scientific Research Institute for Graphite-Based Materials.

**Principal Developers and Producers, Price Levels**

| Type of material | Russian firms | Principal firms in world market | Approximate price per 1 kg of material in world market ($) | Approximate price per 1 kg of material in Russian market ($) |
|---|---|---|---|---|
| Metallic materials | NPO VIAM, NPO VILS, NPO Saturn (Moscow) | Boeing, International Nickel, General Dynamics, Northrop, United Technology (USA), Dassault (France) | 100-120 | 10-50 |
| Ceramic materials | NPO Tekhnologiya (Obninsk), NPO Kompozit (Kaliningrad, Moscow Oblast), NPO VIAM, State Scientific Research Institute for Graphite-Based Materials (Moscow) | Marshall Space Flight Center, General Dynamics (USA) | 50-70 | 5-30 |
| Composite materials | NPO Kompozit (Kaliningrad), NPO Tekhnologiya (Obninsk), NPO VIAM, State Scientific Research Institute for Graphite-Based Materials (Moscow) | Boeing, General Dynamics, Northrop (USA) | 120-150 | 20-60 |

**Russian Technologies Flowed Across the Boundary**

Unfortunately, Russian firms for the time being are operating for the most part using old technological development methods. New work requires thoroughly adequate financing which can be ensured only when the entire aerospace complex emerges from its crisis and its domestic and foreign markets are restored. Direct foreign contracts for the sale of technologies concluded during the last year or two by Russian firms have proven their practical worth but are no more than a tactical solution for the problem of retaining their place among the world leaders of the branch.

Among the partners who have already concluded contracts are the following: NPO VIAM and the ONERA company in France (coverings based on carbon and carbon-carbon materials); NPO VIAM and Dasso in France (attachment parts from niobium alloys with antioxidation coverings); NPO VIAM and the SEP company in France (intermetallide materials of the nickel-aluminum and titanium-aluminum type); NPO Tekhnologiya and the ONERA company in France (fibrous quartz-based heat-shielding materials); NPO Kompozit and the CSIRO company in France (carbon-based composites); NPO VIAM, NPO Tekhnologiya and Beijing Institute of Aviation Materials (nickel and titanium alloys, including equipment for their production, construction ceramics). It is assumed that the financial receipts from foreign contracts in 1993 will amount to about 1/5 of total amount of income for the firms engaged in development work on aerospace materials.

Negotiations and consultations are now underway for concluding contracts between the NPO VIAM, NPO Kompozit, NPO Tekhnologiya and Rolls Royce in Great Britain, Goldschmidt G.A., MTU Munchen (Germany), United Aircraft, United Technologies and Dow Corning in the United States, and the Indian Space Agency. In addition, Russian developers of such materials evidently will receive subcontracts in connection with the Russian-American project for the orbital station Alpha. For the time being it has not come to the handing out of these orders, but hypothetically the priority in such awards will be to the Kompozit enterprise as the firm traditionally belonging to the rocket-space complex.

The Russian presence in the world market is gradually expanding. American companies, not interested so much in Russian technologies as in the economic optimization of their projects by cooperation with Russia, are ready to place orders in Russia for finished products, including the development and production of materials. With respect to West European companies, they specifically covet Russian technologies (which they need, in particular, in connection with work on the HERMES and HOTOL spaceplanes).

**World Market**

The world market for materials for aerospace machine building by the beginning of the 1990's was about 15 billion dollars (including Russian production in world prices); about ⅓ of the volume of this market was accounted for by Russia. This share, unquestionably, has now undoubtedly decreased due to the general economic crisis in Russia. The United States is taking the leading

role in the market. The principal group of goods, as before, remains metallic materials, despite a tendency to their being squeezed out by ceramics and composites (see diagram).

**Aerospace Materials**

The creation of modern types of aviation and space equipment requires the development of materials having enormous resistance to mechanical loads, high pressures, aggressive media, high temperatures and multiple changes in operating mode.

Most of the market is accounted for by metallic materials: based on aluminum (covering of wings, structural and reinforcing components), nickel (heat-resistant components of gas turbine engines), iron (reinforcing components), titanium (structural components, skin and attachment components, lines), materials with a high melting point—molybdenum, niobium, tungsten (nozzles, control surfaces, structural and attachment components), intermetallide compounds (high-temperature units). Ceramic materials (based on graphite, oxides, carbides, borides) are used as coverings of metals for their protection against oxidation, wear and erosion, and also as heat-shielding elements, and in the future—as engine components. Composite materials (a combination of materials of the type metal-ceramic, ceramic-ceramic, polymer-polymer) are used as components of the skin, propellers, compressor blades, ailerons, other control surfaces and chassis, for the skins of rockets and in structural components of fuel tanks.

## Fly-Back Booster Said To Be Most Promising Design for Reusable Aerospace System

*947Q0044A Moscow NEZAVISIMAYA GAZETA in Russian 14 Dec 93 p 6*

[Article by Lev Kamanin, candidate of technical sciences: "A Single Step From Cosmic to Comical. Curious End to Discredited Offspring of the Cold War Era"]

[Text] Five years have elapsed since the day of the first Buran flight. And the last: all work on the ill-fated shuttle has ceased and one of its three copies has been delivered to Gorkiy Culture Park where in the spring of the coming year the presentation of a new space attraction should occur. This mind-boggling stunt puts an end to 20 years of efforts of several hundred enterprises of the military-industrial complex in creating an aerospace complex costing the state over 20 million rubles in the old preinflation prices. There's no doubt about it: the Buran, as the world's most expensive attraction, was guaranteed entry into the Guinness Book of Records. It appears that it is but a single step from cosmic to comical...

Is such a curious end legitimate? How could it happen that the work of hundreds of thousands of highly skilled designers, engineers and workers was necessary to no one and will go only to please the unexacting tastes of latter-day multimillionaires seeking "nonterrestrial sensations?"

Many responsible leaders of our rocket-space industry even today assert that the Energiya-Buran complex is a major scientific-technical achievement and the discontinuation of its further development was caused only by financial difficulties arising with the onset of the changeover to a market economy in the country. But if the Buran is so good as it has been made out to be, why was it impossible for it to replace the Soyuz ship already created in the 1960's?

It is time to acknowledge that the Buran, only once flying into space in an automatic mode on 15 November 1988, is a discredited offspring of the cold war era when the Soviet government allocated the lion's share of the state budget to direct and indirect military expenditures, being guided by the principle: "We will spare no cost..."

This same principle was naturally followed by the creators of our first aerospace complex supposedly with multiple reusability. By order of the Ministry of Defense they designed and constructed an orbital glider (on the Buran there is no propulsion engine, in contrast to the Shuttle—the American orbital aircraft). But a glider, as is well known, cannot take off by itself. And then it was decided that the putting of the Buran into orbit would be delegated to the superpowerful and ultraexpensive Energiya booster, both stages of which tumble to the ground in heaps of scrap metal several minutes after the launch.

The result was astounding: the cost of one flight of the multireusable shuttle was ten times greater than the expenditures on launching of the single-use Soyuz. Moreover, even prior to the Buran flight it had become clear that in the foreseeable future there would be no call for its 30- ton payload capacity. For regular communications with the Mir station and even for the construction of an orbital station of a new generation it is entirely adequate to have a ship with a load-carrying capacity not greater than 10 tons.

In the history of national cosmonautics the undertaking with the Buran enters as a very important engineering blunder—the second after the failure with the sorrowfully remembered N-1 lunar rocket, all four experimental launches of which ended with enormous explosions. It is important not to allow new miscalculations in the stage of conceptual designing of aerospace systems of the future. Unfortunately, the prerequisites for such miscalculations are already in place.

The MAKS project was developed at the very same NPO Molniya where the Buran was constructed: it is proposed that this sort of "Little Buran" orbital aircraft, three times smaller in size and mass, be sent into space from aboard the giant Mriya transport aircraft. One has to ask: is the game worth the candle? Indeed, the speed to which the Mriya will be able to propel the orbital aircraft does not exceed 3% of first cosmic velocity.

Whereas the MAKS is oriented on the use of a two-stage complex, which although low velocity is an already existing entity, as the first stage, in a number of other

projects reliance is on accelerating aircraft, which for the time being still remain mythical. From time to time even completely irresponsible calls are made to proceed to the technical designing and construction of an experimental copy of a single-stage spaceplane not having any parts separable in flight.

In such projects, whose first variants were proposed about 30 years ago, provision is made for a too lightweight approach to the problem of creating highly efficient and reliable hypersonic air-jet engines, involving primarily the development of adjustable hypersonic air intakes and ensuring a stable process of hydrogen combustion in a supersonic air flow. For the time being it has not been possible to solve this problem fully, even theoretically. But from the practical point of view it must be admitted that air-jet engines, capable of reliably operating under the enormous thermal and mechanical loads of hypersonic flight, can be created only on the basis of 21st-century materials and technologies.

As indicated by experience in aircraft construction in our country and abroad, from 8 to 15 years will be spent on the designing, construction and testing of an aircraft engine—two or three times greater than on the development of a new aircraft. Therefore, one should not think in terms of realization of projects for a two-stage (much less a single-stage) spaceplane in the years immediately ahead.

The multiply reusable aerospace system most promising with respect to the possibilities of its embodiment in metal with the use of already mastered technologies must be considered a two-stage complex whose first stage is a rocket plane, that is an aircraft carrier with liquid-propellant jet engines. In such a system a vertically launched rocket plane carrying an orbital aircraft (second stage) is propelled to estimated hypersonic velocity, after which it descends in a gliding flight and makes a landing like an aircraft at a stipulated airfield, whereas an orbital aircraft outfitted like the Shuttle has its own liquid-propellant jet engine and is prepropelled to first cosmic velocity. Performing its assigned task in orbit, the orbital aircraft returns to the place of landing of the rocket plane for preparation for a repeated flight.

A reasonable question may arise: do we have to be concerned at all with aerospace systems during such difficult times?

We will not delve into profound reasonings on the subject of the irreversibility of scientific-technical progress. We will simply recall how the cosmonauts returning from a regular expedition to the Mir station were retrieved from the Soyuz ship. Over the landed ship the search team set up a step ladder with a block and tackle, by means of which the cosmonauts were extracted through the narrow hatch. Debilitated in the course of the Soyuz descent by the operation of 8-g acceleration after prolonged exposure to weightlessness, with forced smiles on their faces they sat down in the seats prepared for them...

But now the astronauts flying in the Shuttles in all flight stages need not experience accelerations greater than 3 g. And it must be surmised that they leave their ship after landing almost with the same ease with which passengers of a modern airliner descend along the stairs. They are to be envied!

## Air-Launch of Converted SLBMs Planned for 1996-97

*947Q0038A Moscow MOSKOVSKIYE NOVOSTI in Russian No 44, 31 Oct 93 p B12*

[Article by Andrey Lomanov: "Aerokosmos Will Be Launched in Two Years. Sea-Based Missiles Also Are Launchable From Aircraft"]

[Text] All modern Russian ballistic missiles (SLBMs) with which navy submarines have been outfitted have been constructed at the state missile center Design Bureau imeni V. P. Makeyev (Miass). With the reduction of strategic arms good possibilities are being afforded for the transformation of military into commercial carriers. The bureau has proposed two fields for use of naval submarines for putting peaceful research or technological satellites into space or into the upper layers of the atmosphere.

The Priboy project (BMN N 39) was oriented on the launching of missiles from the sea surface. The Aerokosmos project proposes that heavy aircraft, especially the An-124 "Ruslan," and in the future, the An-225 "Mriya," be used as launch pads. The rocket engine (it is proposed that reoutfitted SS-N-23 and SS-N-20 engines be used) is fired only after the launch pad, together with a parachute system, descends from the aircraft to an altitude of about 12 km. The launches can be made at a distance up to 4000 km from airfields (superclass or first class).

Despite such different launch methods the Priboy and Aerokosmos projects combine a high operability, mobility and total autonomy. They do not require a cosmodrome and these means that there is no need for alienating extensive areas beneath the zone of falling of spent stages.

An extremely important circumstance is that an object can be attached to a rocket on vessels or aircraft directly at the bases of the client (in some cases this will help in avoiding COCOM restrictions).

As reported by Rem Kanin, head of the KBM laboratory, the commercial operation of the Aerokosmos system will presumably begin in 1996-1997. The Shtil-3A (SS-N-23) rocket can be put into an equatorial orbit with an altitude from 200 to 700 km with a payload 730-950 kg.

BMN: The AO Aerokosmos (founders—State Rocket Center Design Bureau imeni V. P. Makeyev and the Chelyabinsk association Tekhnopolis) was established for realization of the project. The association RAMKON, AO Volga-Dnepr and a number of design bureaus and scientific research institutes participating in the reoutfitting of SLBM intend to take part in the project.

Telephone GRTs KBM: (35135) 2-60-37, 2-63-33. FAX: (35135) 5-22-91

## Remote Manipulator Arm for Buran Tested

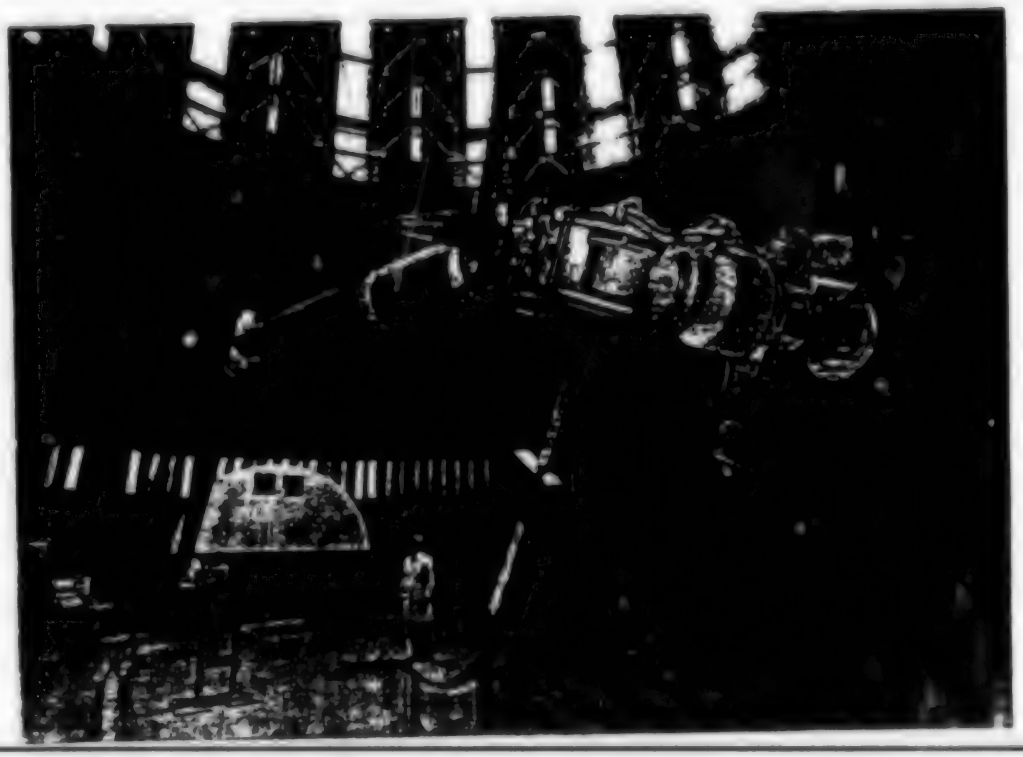
*947Q0038B Moscow MASHINOSTROITEL in Russian Sep 93 p 2*

[Unsigned item: "Arm for the Buran"]

[Text] St. Petersburg. At the Central Scientific Research Institute of Robot Technology and Technical Cybernetics specialists are completing testing a manipulator for the Buran, a multiply reusable space ship.

This original development of the body of institute scientists and designers is intended for putting satellites and scientific modules into orbit and removing them from orbit and has the same many degrees of freedom as the human hand. The length of the space "arm" is 15.3 m, its mass is 350 km and the rate of movement of a load weighing up to 30 tons (in space) is about 4 cm per second. The principal model of "arm" control is automatic, but a manual mode, with the operator's intervention, also is possible.

The photograph shows finalization of spatial tests of the manipulator.



### Annual, Semiannual, and Seasonal Variations of Total Ozone as Deduced From TOMS Data for the Region of St. Petersburg

*937Q0058A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 93 pp 18-26*

[Article by K. Ya. Kondratyev, K. Varotsos, International Center for the Environment and Remote Sensing imeni Nansen, St. Petersburg; Applied Physics Faculty, Athens University; UDC 558.88.042.4:551.534]

[Abstract] Nimbus-7 TOMS data collected daily over a 13-year period (January 1979 to January 1992) was used to analyze total ozone variability over St. Petersburg. Average monthly total-ozone values were subjected to Fourier analysis in order to calculate the amplitude, phase, and relative contribution of each of the three first harmonics to the overall total-ozone variability. The principal conclusion reached by the researchers is that heterogenous chemical reactions result in a modification of the usual chemical processes in the Arctic circumpolar vortex, which in turn enhances total-ozone depletion of anthropogenic origin. The effect is also seen in the middle latitudes as a result of the movement of air masses from the polar latitudes when the circumpolar vortex breaks down. A negative gradient obtains for active chlorine away from the pole, and the movement to the middle latitudes stimulates processes that destroy ozone. Figures 3, references 21: 4 Russian, 17 Western.

### Recursive Nonlinear Filtration of Binary Images

*937Q0058B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 93 pp 51-56*

[Article by V. V. Yanshin, Institute of Animal Evolutional Morphology and Ecology imeni A. N. Severtsov, Moscow; UDC 391.621.25]

[Abstract] Images produced in the sensing of the Earth's surface with active and passive space-based systems are represented in binary form, with subsequently preliminary processing. Part of that processing involves local filtration. The work reported here examines procedures for recursive nonlinear filtration. A mathematical model of the procedures is constructed, and the probability efficiency of a recursive filter is compared with that of a nonrecursive filter (maximum probabilities of events are $y = 1$ and $y = 0$. With $p = 0.1$, the recursive filter produced a probability value of $P = 0.0122$, whereas the nonrecursive filter produced a value of $P = 0.28 > 0.0122$. With $p = 0.9$, the values changed to $P = 0.9882$ and $P = 0.972 < 0.9882$, respectively. By and large, a $(2/3)_3$ recursive filter produced better values than those of a similar nonrecursive filter. References 6: 4 Russian, 2 Western.

### Combined Use of Onboard Standards and Reference Areas of the Ocean Surface for Calibrating Satellite-Based Microwave Radiometer Measurements

*937Q0058C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 93 pp 57-65*

[Article by B. Z. Petrenko, Institute of Radio Engineering and Electronics, Russian Academy of Sciences, Moscow; UDC 528.852.4]

[Abstract] Reliable absolute calibration of microwave radiometers is critical to the solution of inverse problems of satellite-based passive microwave sensing. Two techniques are used for absolute calibration—onboard calibration (which uses radiation either from manmade sources or from natural sources unrelated to the target being sensed, or both) and external calibration (which uses contrast areas of the Earth's surface). The sources in the first technique are called standards; those in the second technique, references. Since both techniques have merits and drawbacks, the researchers chose to combine their use in a technique based on precise knowledge of equivalent brightness temperatures of the standards and geophysical parameters of the reference areas. In the context of the estimation of accuracy associated with the determination of ocean-surface temperature and total water vapor mass in the atmosphere, they demonstrated that the new technique makes it possible to relax the requirements associated with onboard standards in achieving acceptable accuracy in determination of geophysical parameters. With external calibration based on reference areas alone, estimates of calibration factors were stabilized. When onboard standards were highly accurate, their use made it possible to raise the precision associated with the determination of absolute values of geophysical parameters. Figures 6, references 12: 10 Russian, 2 Western.

### Meeting of the Section 'Space-Based Natural-Resource and Ecological Research' of the Russian Academy of Sciences Space Council

*937Q0058D Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 93 pp 122-124*

[Article by M. G. Krasnogorskiy, P. A. Shirokov; UDC 528.8]

[Abstract] The Space-Based Natural-Resource and Ecological Research Section of the Russian Academy of Sciences Space Council met on 15 March 1993, in Moscow. The meeting was devoted to a discussion of the results of scientific research conducted aboard the Almaz-1 station and to the prospects of further research in the Almaz program. V. V. Viter, first deputy general designer at NPO Mashinostroyeniye gave the keynote speech, in which he recounted the history of the Almaz spacecraft, the first of which was launched on 25 July 1987, under the name Kosmos-1870. Almaz-1 lifted off some four years later, carrying an improved radar complex, whose resolution had been brought down to 10-15

m. The next in the series, Almaz-1B, is being readied for launch in 1996. The new spacecraft will carry a radar complex that consists of three sets with wavelengths of 3.6 cm, 9.6 cm, and 70 cm. Resolution of the sets will be down to 5-7 m. The spacecraft will also be outfitted with high-resolution electrooptical equipment, spectroradiometric and electron-scanning gear in the visible and IR ranges, and a lidar set. It should be about five years ahead of similar craft in the West. Almaz-2, which is slated for launch in 1999, will be multifunctional in that it will study the Earth and its atmosphere and will serve to produce general models of the ocean-atmosphere system, global biosphere dynamics, and the effect of land energy budget on climate. Papers were read on the following programs: Briz (study of coastal waters and inland water bodies; identification of pollution sources); Geos-A (geoecological study; geological mapping; geological monitoring); Almaz-Agro (studies of soil fertility and crop conditions); Resurs-A (study of natural resources); Okean-I (development of radiophysical techniques for studying the ocean; study of propagation of surface and internal waves).

## Russia's Position in World Market for Space-Based Monitoring Systems

*947Q0041A Moscow KOMMERSANT DAILY in Russian No 234, 4 Dec 93 p 8*

[Article by Sergey Morgachev and Ilya Neyman: "The World Must Be Viewed From Above"; the first paragraph is an introduction and the last six paragraphs provide general information]

[Text] Images of the Earth's surface obtained by space monitoring, once of interest only to the military, have now become the object of an extremely large-scale business whose scope, according to a number of estimates, already exceeds a half-billion dollars. Monitoring data are valuable for organizations and enterprises engaged in exploration for and production of mineral resources, agriculture and the fishing industry. They are needed by all who are associated with ecological problems, prevention and elimination of the consequences of natural and man-induced catastrophes.

Space photographs, which "in color" are rather impressive, were on display at the International Exhibition "Oil and Gas-93," which ended yesterday in Moscow, including in displays of the Priroda and Soyuzkarta enterprises. The situation in the world market for these products is discussed by our reviewer Sergey Morgachev and our expert Ilya Neyman.

### Photograph Business; Four Points of Reference

Four factors can ensure success in this specific market: low costs for the launching and production of satellites, high quality of the images themselves (equipment resolution and a number of other special characteristics), high quality of equipment and technologies for the interpretation and processing of images and, finally, the presence throughout the world of a well-developed network of points for the reception and processing of telemetric information (this ensures routineness in the client receiving the desired product). In the first and second links of this chain Russia has completely competitive positions, in the third the situation is uncertain, but in the fourth Russian enterprises for the time being have not moved from the starting line.

Production costs and the cost of launching a payload into orbit in Russia, as is well known, are an order of magnitude below the world level. If one speaks of the equipment carried on satellites operated by civilian organizations, Russian technology has superior characteristics (see table). With respect to military satellites for visible reconnaissance, there are no precise data on Russian capabilities (the American photosatellite KN-11 ensures a resolution up to 15 cm, whereas the Lacrosse radar satellite ensures a resolution up to 60 cm). However, here it is not the technical level in general which is important, but the characteristics specifically of that equipment which is used for commercial purposes. According to the specifications of the Russian government (August 1992), for commercial purposes it is possible to use equipment with a resolution up to 2 m, which unquestionably will provide Russian users of this technology advantages in technical competitiveness. However, it is unknown how long this advantage will persist: in the United States the possibility of declassifying photographs with a resolution up to 1 m is already being considered.

The general backwardness of Russia in computer technology is greatly limiting its capabilities for creating image processing outfits. If one speaks of the processing of optical information, for the time being there are no alternatives to the use of imported equipment. The situation is more encouraging with respect to the processing of radar information: at the NPO ELAS a highly productive processor has been developed and already is in use in which a number of original technological solutions have been introduced.

The only Russian foreign terminal for the reception of satellite information is located, evidently, at the Military Technical Reconnaissance Center operated at Lourdes (Cuba), but it is only possible to make proposals on the incorporation of this terminal into commercial operations.

### A Foreign Network Must Be Established

Insofar as is known, in Russia there are now four organizations engaged in the processing and commercialization of satellite images: the Almaz enterprise (founder—NPO Mashinostroyeniye, Reutov, Moscow Oblast), working with radar images from the Almaz station; the Sovinformsputnik enterprise, working with photographs from military satellites (founders—Central Special Design Bureau, Samara, and two other government agencies which the authors promised not to mention); the AO Soyuzkarta (founders—private individuals; this organization inherited the functions of the former VO of the same name) and


**World (primary, commercial) production market associated with space monitoring (estimate).**

Key: 1. LANDSAT system, EOSAT consortium 2. ERS system, European Space Agency, Eurimage consortium 3. less than 4. Resurs-F system, Russian military reconnaissance satellites, Priroda State Center, Soyuzkarta, Sovinformsputnik, Almaz enterprises 5. SPOT system, France; Spotimage enterprise 6. Enterprise responsible for the processing of photographs, sale of information and equipment

the State Center Priroda as part of the Russian Federal Service for Geodesy and Cartography. Priroda and Soyuzkarta are commercializing photographs of satellites of the Resurs-F series.

The scales of activity of these enterprises constitute a commercial secret, but it can be assumed that real business for the time being is going on only at the latter two organizations, long concerned with this business and having the experience and the clientele. Taken together, with an optimistic estimate, their annual sales may now be about a half-million dollars. A primary product (copies of photographs) and its derivatives (photoplans, photomaps) are produced. As a rule reference is to a low degree of processing, although there also are orders for preparation of a complex product. The activity of Sovinformsputnik and Almaza for the most part is of a publicity nature and evidently their transactions do not exceed the limits of tens of thousands of dollars annually. In general, however, the share of Russia in the primary world market for satellite photographs and their derivatives in any case does not exceed 1%.

There are several reasons for this. First of all—the stiff opposition of American and West European competitors who control the market; this applies to both the sale of the "raw product" and to a still greater degree to the processed product (Russian enterprises began to work in the Western market only several years ago—earlier their activity was restricted to the socialist countries). Second, the incompatibility of processing standards, making the sale of the processed material very difficult. Finally, the problem of a foreign network. Accordingly, the approach to success lies in the broad use of imported interpretation equipment and the adaptation of Russian analogues to Western technologies, agreement with Western partners on the organization of a unified network of surface complexes and changeover to work with information in digital form. And, finally, simply through stubborn marketing. This activity scarcely will bring success in Western Europe, where the influence of France and the United States is too great; the most likely chance is to exploit old and new connections in the developing countries. If Russia has pretenses to broadening its share in

the world market, it must also incorporate the strictly technical trends in this sphere—for example, the use of systems of light artificial earth satellites launched by light inexpensive boosters. Such a project is now being developed by the Alenia Spacio Company (Italy) and in Russia by the NPO Energiya.

**Commercial Space Monitoring Systems**

| System | Country, general contractor | Resolution | Average price per photograph (image 1 km$^2$) ($) Realized projects |
|---|---|---|---|
| Resurs-F (o) | Russia, TsSKB | 5-8 | 1500/0.50 |
| Military systems (o) | Russia, TsSKB | 2 | 3000/2.00 |
| Almaz (r) | Russia, NPO Mashinostroyeniya | 10-15 | 1000-2000/no data |
| LANDSAT (o) | United States, no data | 30 | 3600/0.10 |
| SPOT (o) | France, Matra | 10-20 | 2000/0.55 |
| ERS-1 (r) | ESA, Dornier | 25 | no data New projects of the 1990's |
| Almaz 1-V (o,r) | Russia, NPO Mashinostroyeniya | 2.5, 5-7 | no data |
| Resurs-Spektr (o,r) | Russia, TsSKB | 10 | no data |
| Resurs O-1 (o) | Russia, VNIIEM | 25 | no data |
| SOEK (o,r) | Russia, NPO Energiya | 2, 5 | no data |
| RADARSAT (r) | Canada, SPAR | less than 10 | no data |
| LANDSAT-6 (o) | USA, AIRSPACE | 5-15 | no data Notations: (o)—optical, (r)—radar. |

The optical equipment for satellite monitoring systems is produced in Russia by the Krasnogorsk Mechanical Plant (Moscow Oblast); development work is carried out by the State Optical Institute (St. Petersburg). The developers and producers of radar apparatus are the NPO Vega, Scientific Research Institute for Precise Instruments, Special Design Bureau EI (Moscow) and the NPO ELAS (Zelenograd).

What is Space Monitoring? It includes exploration for minerals; monitoring of the state of agricultural areas, forests, ice, the world ocean and its resources, and in general the state of ecosystems; warning of and elimination of the consequences of natural misfortunes (drought, floods, fires) and industrial catastrophes (tanker accidents, toxic effluent, etc.).

Monitoring is carried out using optical and radar apparatus aboard space vehicles. The information is "dumped" through radio channels to surface telemetric complexes or in the form of a film, passes through a greater or lesser number of computer processing stages and is trasmitted to the client, usually along communication lines in digital form.

**Who's Who in the World Market**

The world market for space monitoring products is, according to approximate estimates, 50-100 million dollars annually. This is the primary market, that is, sales of companies which have access to the initial information from satellites. Their products pass through several processing stages and then the price may increase in comparison with the initial cost by an order of magnitude or more. As a result, according to estimates, the market attains 500 million dollars, although here there is evidently repeated recalculations involved.

In the market the leader is the French company Spotimage, operating the SPOT satellites. In contrast to the LANDSAT and ERS projects (see diagram), to a considerable degree oriented on the finalizing of technologies, the initiators of the SPOT project from the very beginning took measures for active advertising, establishment of a strong information-technical and commercial network.

If one reckons the final costs and revenues in this business, it is unprofitable: the expenditures on the development of satellites, their launching and operation, are too great. But the government (both in the United States, in France and in Russia), pursuing strategic goals, is assuming a large part of these expenses, which makes possible profitable operation of the commercial firms.

## Commentary on Statute for State Support to Space Sector

*947Q0069A Moscow NEZAVISIMAYA GAZETA in Russian 14 Jan 94 pp 1, 2*

[Article by Dmitriy Payson: "Russian Cosmonautics: Ordered To Concentrate. The Need Has Arisen for Restructuring"]

[Text] A resolution of the government of the Russian Federation entitled "State Support and Protection of Space Activity in the Russian Federation," dated 11 December 1993, was published in ROSSIYSKIYE VESTI on 11 January 1994 and thus was put into official force.

The resolution was adopted against the background of developing work on construction of the joint Russian-American orbital station, the Alpha. Finally, the Russian Space Agency (RSA), it appears, has found its place amidst the giants of national rocket building. From now on it is planned that all funding of the Russian Federal Space Program be through the RSA. For this purpose it is proposed that the agency be allocated an antedated 164.8 billion rubles for 1993, and for 1994—274.8 billion. Other than the RSA, only the military space forces are designated as users of space vehicles.

It must be said that considerable work on the development of the juridical base of national cosmonautics was carried out in the Commission on Communications, Information Science and Space ("Adrov Commission") of the former Supreme Soviet. Without question the preparers of the new resolution made use of the accumulated experience. However, for the first time a number of interesting innovations are appearing in such a high official document.

Although the situation with the Baykonur cosmodrome has been normalized for some time and agreements have been reached with the Kazakhstan side and although the funding of the principal cosmodrome of the former USSR is especially provided for, the new document proposes to interested organizations that in a month's time they present to the government proposals on the further development of Russian Plesetsk and on establishing a new cosmodrome in the Russian Far East.

Thus, there has been official continuation of the "Blagoveshchensk Project." Since due to purely physical reasons it is possible to put considerably lesser loads into space from northern Plesetsk than from the lower latitudes, and since Baykonur seems none too attractive from the political point of view, the civilian and military rocket users of Russia are unified in their desire that something new be constructed. All the moreso since launchings of the heaviest (other than the stillborn Energiya) Russian rocket, the Proton, are impossible from the Plesetsk test range, making it is quite necessary to construct launch facilities. It is assumed that if they are to be built, it is better that it be done to the southeast. The spent stages in this case will fall in the ocean and the protests from Kazakh, Yakut and Nenets herders should probably cease. If two launch sites are constructed for Protons in the Blagoveshchensk region in the Far East, then naturally a duplicating center of Russian cosmonautics will take shape, taking into account the only station in Russia for the monitoring of distant space with the 70-m antenna at Ussuriysk and the reserve airfield for the Buran at Khorol. It is true that it is a long way to transport Protons from Moscow.

In addition to the Far Eastern project, there is the quite exotic project of the NPO Energiya, which has been kicked around in its time, the construction, on the basis of the model and similar to the Italian San Marco, of a floating platform for the launching of rockets from equatorial waters. The payload, to be sure, is increased, but there is a corresponding increase in the load on the long-suffering space budget. It is probably necessary to forget the platform for the time being.

Reading between the lines in the new documents, one can visualize the direction of further restructuring and concentration of national aerospace. Fully in accordance with market conditions an individual item provides for the allocation of preferred conversion credits for ensuring the production of technology in conformity to a specific list. If this list is comprehensive and if survival of the enterprises and organizations not included in the list is not contemplated, the fate of a number of facilities and projects becomes clear—they will die. Reference, in particular, is to the construction of solid-fuel boosters, including those based on ballistic missiles from submarines (Machine Building Design Bureau at Miass in the Southern Ural); to the further production of the light Kosmos booster at the Omsk Polet Production Association; finally, to the Buran system and in general winged spacecraft. The Tushino NPO Molniya, building the Buran spaceplane, is not named in the list, but the Buran, together with the Energiya, on the other hand, were mentioned in a "requiem" press conference of Yuriy Koptev, RSA director, at the end of the year. The Buran is not to be. The only thing which can be recommended to the devotees of romantic spaceplanes is to await the opening of an elite restaurant in Gorkiy Park which will be placed aboard one of the Burans.

However, some of the projects will probably be taken over by the military. A number of their main organizations are not mentioned in the document, but without their support the projects are unlikely to survive. With respect to the "civilian segment," it is evident that the giant established by Academician Korolev, the NPO Energiya, now bearing his name, as before has a special status in Russian space plans.

Although the NPO (strictly speaking, it is unknown on whose initiative, up to now specific individuals are either dissociating themselves or whitewashing themselves after the fact) in my opinion has somewhat lost its initiative and dynamic character, in the mid-1970's getting itself involved in the venture with the Buran, the continuing cooperation with the American NASA on the

orbital station is again advancing the enterprise at Podlipki into a privileged position. The several hundred million dollars to be received from the Americans is entirely comparable to the entire Russian space budget for a year or two. In addition, the NPO Energiya traditionally has carried out such functions and also has had such subdivisions which throughout the world have usually been regarded as governmental. The cosmonaut detachment, for example. Most of the directors of national cosmonautics and the military-industrial complex in general (including Aleksey Adrov, the former chairman of the Supreme Soviet commission, and Yuriy Baturin, the newly designated presidential assistant on national security) came from Podlipki. The latest resolution strengthens this special status even in details—the next to the last item in the resolution allows the RSA to have the additional post of deputy general director. This post is set aside specially for Yuriy Semenov, the present-day general designer of the NPO Energiya.

Whatever you say, the structure of the space complex in Russia has taken on a monstrous form. Bad enough that a number of enterprises of the once unified military-space complex are now located abroad, primarily in the Ukraine, but also in Kirgizia and in Uzbekistan, not to mention Baykonur. The responsibility for clear-cut implementation of the government space program has been capriciously distributed between the state RSA and industrial enterprises (Energiya) which are being privatized. The very same American NASA, unquestionably a government agency, but having in its makeup very well-developed research and planning centers, is able to turn to private enterprises of the aerospace industry only with specific government orders. This is funded by a budget approved by the congress. Therefore, the time has come for a restructuring of the Russian space infrastructure. However paradoxical it may seem, the guardians of government interests in most cases are the directors and specialists of privatized scientific-production enterprises rather than a new generation of oversight people from state offices. It must be assumed that despite all the swingings of political vanes the hand on the pulse of Russian cosmonautics will continue to be held by the chief designers and the heads of design sections, and not only by managers and administrators.

Although many specialists, even at this same NPO Energiya, and particularly in the "outer circle," consider that it would be useful to establish a Russian NASA. This dream was mentioned once again during the monthlong period, but the dream evidently died on 11 January. It must be assumed that soon we will learn what direction the restructuring of national cosmonautics will take. It can be assumed that in Moscow, and probably in Krasnoyarsk (communication satellites), several federal space centers will be established, as stated in the resolution, for the concentration of efforts.

The legendary Konstantin Tsiolkovskiy prophesied the arrival from space of "mountains of grain and unlimited power." Present-day rocket specialists prefer a bird in the hand to two in the bush. It is best to remind our excessively pragmatic comrades once again how at one time such pragmatism forced Isabella of Castile to finance the voyage of Columbus.

## Russian Space Policy Said To Repeat Past Mistakes

*947Q0068A Moscow MOSKOVSKIYE NOVOSTI in Russian No 52, 29 Dec 93 p B12*

[Article by Aleksandr Borodulin: "Space Expenditures Enter the Budget as a Separate Item. Oriented on Large-Scale Prestigious Manned Flights, Russian Cosmonautics May Repeat the Errors of the Soviets"]

[Text] The government of the Russian Federation, in approving the federal space program for the period up to 2000, allowed the RSA (Russian Space Agency) to make advance payment for purchase of standard space complexes in an amount of 30% of their cost (as is the practice in the defense industry). The Ministry of Economics and the Ministry of Finance in preparing the 1994 budget were told to put all space expenditures in a separate item. The RSA will receive 167 billion rubles of appropriations for research, development, testing and engineering work, 16 billion for the maintenance of surface services, 10 billion for capital construction and 81.8 billion for the purchase of standard- produced equipment. And in 1993 (in actuality antedated) the branch was allocated 164.8 billion rubles. In essence this money represents the state debt for research, development, testing and engineering work already done and for purchased equipment, compensation for expenditures for the maintenance of cosmodromes, etc. A resolution of the Council of Ministers provides for preferred conversion credits for only 16 branch enterprises. Budgeted funding can only ameliorate, but not fundamentally improve the difficult financial situation of the RSA. The RSA is accordingly laying great hopes on cooperation with NASA and the ESA (European Space Agency). The agreement signed in December by Viktor Chernomyrdin and Albert Gore, jvice president of the United States, provides for the launching of the Russian-American orbital complex Alpha (in addition to work on the androgenous docking units and the joint manned flights in 1994-1997, which will cost 100 million dollars annually, etc.). In the words of Vladimir Pivnyuk, a government space expert, the American project for the launching of the Freedom orbital stations experienced a failure—the Bill Clinton administration has sharply reduced the appropriations, although 10 billion dollars had already been invested in the project. A similar situation arose with our Mir 2 space station, all work on which was frozen due to an insufficiency of funding. The total value of the contracts under the Alpha project is 2 billion dollars, of which it is proposed that 400 million be allocated to the Russian side. The RSA has already received 1 million dollars from the Americans for the matching of interfaces (this program is part of stage I of work on the Alpha, also including joint flights in the Shuttle, construction of the Spektr and Priroda biomedical modules and putting them into orbit). In the second stage work will begin on assembly of the station, and in

stage III—its outfitting with special equipment. Yuriy Koptev, general director of the RSA, feels that work on the Alpha project in cooperation with NASA will be twice as cheap for our country than finalizing the Mir on our own efforts. These computations skirt a fundamental question—is it necessary at all for Russia to participate in this project? In the opinion of many leading scientists (in particular, Academician Roald Sagdeyev has written about this more than once, about 97% of the research and practical information is from unmanned automatic vehicles; the contribution of manned flights to science is small and the contribution to the economy is virtually nil. Most likely Russia, recovering from the sharp criticism of purely prestigious space expeditions into orbit, will again return to this direction. The motives are understandable—Russia wants to retain the personnel and technology of a powerful complex, and finally, the status of a great space power. But tactical advantages may be defeated by a strategic miscalculation which the USSR allowed many years ago—concentrating its efforts on the race for the greatest duration of manned flights and the chalking up of records of little significance for science and the economy and disregarding the generous budgetary infusions the branch ignored commercial cosmonautics.

## Current Economic Situation at TsAGI

*947Q0068B Moscow MOSKOVSKIYE NOVOSTI in Russian No 50, 12 Dec 93 p B10*

[Article by Andrey Baranovskiy: "TsAGI Has Reduced the Volume of Aircraft Tests By Two-Thirds. Foreign Aerospace Firms Provide One-Third of the Orders for the Largest Aviation Scientific Research Institute"]

[Text] The TsAGI (Central Aerohydrodynamics Institute) in Zhukovskiy in the Moscow region and its Moscow affiliate in the former USSR carried out virtually all the theoretical work and static tests of aviation technology. The institute has an entirely modern and the world's largest ensemble of wind tunnels (more than 60) for the wind tunnel testing of aircraft and their models. Now, when orders from the principal client, the Ministry of Defense of the Russian Federation, have ceased, the volume of these tests has been reduced by a factor of three. Research related to the Buran spaceship, for which TsAGI had constructed unique test stands such as even NASA does not have, has been stopped in its tracks.

Nevertheless, today the institute is supplied with resources adequate for carrying out research, development, testing and engineering work at the very highest technical level (40% of the TsAGI orders are received from the Russian space and defense industry, the Ministry of Science and Technical Policy and the Russian Space Agency, 27-30% of the work is funded by agreements with aviation design bureaus and the rest is earned by filling orders from foreign aerospace companies).

Among the foreign partners the first place is occupied by the Boeing Corporation, with which the institute has been cooperating since 1991. Major orders have been placed by French, but also by German, Indian, Japanese, South Korean and British companies (research on the An-226 "Mriya-Hotol" aerospace transport system has already been carried out in collaboration with British Aerospace for more than 2.5 years).

Cooperation with Chinese enterprises is developing in three directions: testing of models of civilian aircraft, modernization of the aerodynamic base of the Chinese People's Republic, reoutfitting of plants producing helicopters.

In the words of German Zagaynov, TsAGI director, there is an extremely high probability that some foreign producers of passenger aircraft will turn to the institute for carrying out tests and certifications of those planes which may be in demand in the Russian market.

The TsAGI also is developing industrial equipment for agriculture, fuel and energy complex branches, medicine and metallurgy. Solar cells for the heating of cottages enjoy a great demand. The institute has served as an organizer for establishing the "Regional Scientific-Industrial Association of the Southeast Moscow Region," which is concerned with the conversion of defense technologies. It is proposed that it will include aerospace enterprises located at Zhukovskiy, Ramenskoye, Lyubertsy, Lytkarino, Reutovo and Balashikha.

Telephone: TsAGI: (095) 556-42-05

## Commentary on Current Space Policy Issues

*947Q0055A Moscow SEGODNYA in Russian 30 Dec 93 p 8*

[Article by Mikhail Chernyshov: ""Seriuses' Descend From Orbit. But Life in Orbit Continues"]

[Text] Once each of our space attainments was broadly discussed in the smallest detail. Now, probably, there are few who remember, other than relatives and workers in the corresponding services, that in orbit—aboard the Mir station—the "Siriuses" have already been working for several months: these are the cosmonauts Vasiliy Tsibliyev and Aleksandr Serebrov. In the course of the first two weeks after the New Year a different crew will take up the servicing of the station. This time it will consist of three persons. Most likely the the inhabitants of the celestial dwelling will be Viktor Afanasyev, Yuriy Usachev and Valeriy Polyakov. In the event of unexpected events three backup cosmonauts have been trained: Yuriy Malenchenko, Tolgat Musabayev and German Arzamazov.

In the course of the impending (number 15) main expedition the world record for spaceflight duration should be broken. The crews will include two physicians: Valeriy Polyarkov and German Arzamazov. They have long specialized on the problems involved in prolonged flights. They know the complexities associated with such expeditions. Valeriy Polyakov in the late 1980's already had spent 241 days aboard the station. Most likely he is

to become a new space record holder. If everything goes as planned, the physician-researcher will work on the Mir not only during the entire fifteenth expedition, which is to end in June, but also on the next shift. A total of more than 420 days.

For what purposes are such complex experiments carried out? Sooner or later new flights will be made to the moon and Mars will be conquered. This means that it is necessary to know the capabilities of the human body. Well, among other things, it is assumed that such multi-sided research will advance fundamental science. Not so long ago in Arizona eight Americans spent two years in a closed surface complex. This was the major Biosphere 2 experiment. The American "bubble" is a gigantic—measuring more than a hectare—glass dome beneath which about 4000 species of plants and animals were placed. The expected grandiose discoveries, as the specialists have written, for the time being have not been realized. Nevertheless, new research cycles under conditions of an almost closed biosphere are being planned.

Russian science leads with respect to space life support systems, today having the richest experience in individual record flights. This, incidentally, is one of the factors inciting the Americans and other Western countries to cooperate with us in the field of creating an international orbital station. In any case the American astronauts, not having the capability for particularly long flights on the Shuttles, already in the next few years are intending a total 24-month experiment with work under weightlessness conditions, participating in research on the Mir.

The agreements signed in December in Moscow by the Russian prime minister Viktor Chernomyrdin and the American vice president Albert Gore signified, it is generally held, a changeover from the Mir program to the Alpha stage. According to the testimony of Daniel Goldin, NASA administrator, as a result of implementation of the project the United States will save 2 billion dollars and approximately two years in the time required for construction of an international orbital station. The participants in the project, in addition to Russia and the United States, also will include the countries of Western Europe, Japan and Canada; they note that none of them individually could construct a station. Now there is definite evidence that the circle of participants in the project, as it is implemented, will possibly expand. The Alpha station, having the Mir 2 module as its basis, will gradually begin to be overgrown with other components, being transformed into a major orbital laboratory. The duration of its operation will be approximately from 1997 to 2010.

According to the testimony of Russian government and space experts, those 400 million which Russia will receive in the first stage of work on the project will facilitate us in keeping the now-operating Mir in a working state and second, to some degree will smooth out those "troughs" which were formed in the fairly long drawn-out restructuring of the Russian space industry.

Vladimir Pivnyuk, an expert of the government of the Russian Federation, is convinced that we have no need, for example, of keeping up nine gyroscope plants. Nowhere in the world does such a thing exist. This means that it is necessary to select only one such plant. But it must be supplied with the most modern equipment, supported by government orders. All the remaining enterprises must become joint stock companies.

A search for market niches both within the country and abroad, however, involves great difficulties. Only a very few companies, such as the Khrunichev plant, the NPO Energiya and Prikladnaya mekhanika (communication satellites), to some degree can ensure themselves with ruble and a very small hard currency earnings. There has been no broad entry of the Russian rocket-space industry into the external market.

An international air show has just been held at Bangalore, where great interest on the part of potential purchasers was manifested, in particular, in Russian military aircraft and helicopters. The Indian press writes in a considerably more restrained manner about Russian space technology. The cracks arising after the unsuccessful "cryogenic deal" still exist, India, convinced by local space experts, may rely only on their own boosters, such as the Agni rocket (in its capabilities it already is approximately equal to the American Pershing). A network of enterprises has been established in the country and includes more than ten plants and research centers.

The Russian side feels that the renewal of normal trade relations with India in the "space" field is possible; it is only necessary to adhere more strictly to the terms of the nuclear proliferation agreement. Without question, there must be a special competence in this sphere: both legal and juridical. In Russia a large excess of intermediate- and low-thrust rockets has been formed, including those which can operate from mobile launchers. The experts feel that there is a large market in the world for these rockets.

## Belarus Space Enterprises Continue Support of CIS Space Program

*947Q0054A Moscow DELOVOY MIR in Russian 28 Dec 93 p 4*

[Article by Dmitriy Patyko: "Belarus: It's More Costly To Leave Space Than to Remain"]

[Text] Should Belarus continue its participation in space research programs? An answer to this question has been sought in the republic for 1 ½ years. Precisely for such a time our country, acquiring independence, has "twirled" the space heritage of the former union, not being able to make up its mind what to do. Not without hesitation was it decided to use it for its direct purpose. In other words, such resources were earmarked under the earlier signed Intergovernmental Program for Space Research and Use, which Belarus decided to carry out together with Russia, the Ukraine and other countries of the Commonwealth.

Boris Beregov, deputy director of the Technical Cybernetics Institute, Belarus Academy of Sciences, chairman of the republic conference on space, states: Only at first glance does it seem that getting out of the expensive space game means the saving of money. Over the course of many decades a unique scientific-industrial capability was formed in the republic which was oriented on the development and production of space systems, instruments and equipment for research on the Earth's surface and atmosphere and the solution of other technological and scientific problems related to the mastery of the universe. To break up the formed infrastructure, to seek a new place for application of the knowledge of specialists (most frequently with a very narrow field of specialization) and to redirect well-organized production to something else is possible only at an enormous cost. An example of this is the Gomel Electronics Plant. It is outfitted with the most modern equipment, including a supercomputer, and has specialists of the highest class who were brought together from the entire Union. Some mathematicians brought about a hundred families from the Novosibirsk Akademgorodok. And now they are mastering the production of lamps and other consumer goods! The Novopolotskiy Izmeritel plant, an enterprise which formerly was so secret and extraterritorial that not many even in the government of Belarus knew of its "space specialization," has found itself in a similar situation. A reasonable owner must not think about how to rid itself from what had been built up over the course of many years, but how to use this wealth in order to bring it income. Thank God we were able to convince the government of the republic of this.

Just what is the nature of the contribution of Belarus to the intergovernmental program? The most important contribution is a fractional participation in the funding of individual projects, the sequence of which is embodied in a special agreement. Sums will be allocated only for tasks to be performed by institutes, design bureaus and industrial plants in Belarus.

In addition to sums taken from budget appropriations for science, in accordance with the corresponding intergovernmental agreement, for the Belorussian share for maintenance of facilities in the space infrastructure, the government of Belarus has allocated money from the Ministry of Finance reserve. For this sum Belorussian standard-produced equipment and materials will be supplied for ensuring the normal operation of cosmodromes. Thus, jobs and production facilities will be preserved.

The program for Belarus includes 32 themes which the institutes and enterprises of the republic had begun to work on (and in most cases have simply continued). It must be noted that the program is being carried out jointly with the Russian Space Agency and this is so-called peaceful space. The military people have their own cooperation and their own plans.

With respect to Russia, it is interested in such a joining of efforts: for the development of such research it would require not only additional appropriations, but also three or four years for organizing corresponding scientific groups and bringing them up to an acceptable level. Well, what is the interest of Belarus in this? Is it only striving to preserve its space intellectual and production capabilities or is it also counting on some return?

"To be sure, we are counting on a return," explains Boris Beregov. "It must not be forgotten that our republic is in a more advantageous position because the principal financial burden for space is not on our shoulders. Much of that which is being done in the space field moreover is of a purely national character and is directed to satisfaction of our own needs. In addition, today possibilities are appearing for making formerly secret technologies available to 'nonspace' production facilities, which also will bring an economic return.

In agriculture, for example, a space survey includes a high-quality evaluation of the condition of soils and monitoring of the fertilization of plants, as well as more successful contending with weeds and predators and reproachless monitoring of the development of sown crops and calculation of yields by species.

Belarus has everything necessary for the processing of satellite information. It is only necessary to organize this work into a system. The first steps in this direction have already been taken. But it is the opinion of scientists that serious work will be possible only with the appearance of a satellite information center and with the raising of this entire service to a state level."

### Programs, Aims of Ukrainian Space Program

*947Q0066A Moscow POISK in Russian No 51, 30 Dec 93 p 13*

[Article by Andrey Yevtushenko: "Satellite With Zaporozhe Accent"]

[Text] The Ukraine wants to be in space. It has all the prerequisites to make a breakthrough into space. We have the Yuzhnoye Design Bureau at Dnepropetrovsk and the Yuzhmash, which is known to just about everyone. There are many of its special facilities with different capabilities, a National Space Agency has been established and there is a fairly good record of scientific accomplishments. In the not distant future plans call for putting a Ukrainian satellite, the "Sich," into orbit. There is least of all any desire to be exotic or to surprise the world. What is most important is the implementation of a grandiose project for remote sensing of the Earth.

"Recently the method for aerospace monitoring of the state of the environment is being used more and more widely," says Vadim Lyalko, corresponding member of the Ukrainian Academy of Sciences, director of the Center for Aerospace Study of the Earth of the Geological Sciences Institute, Ukrainian Academy of Sciences. The scientists of the Ukraine, within the framework of the "Ukrkosmosresursy" and "Kosmos" projects, have

developed and tested original methods and equipment which during sensing in the ranges from ultraviolet to microwave make it possible to solve many ecological problems. These include, for example, an estimate of water saturation of the soils, rise of the water table and salinization of soils, detection of active fault zones, sectors of damage to oil, gas, heat and water pipelines, lands and water bodies polluted by heavy metals, nitrates and petroleum products, search for underground water sources, oil-gas and ore deposits, weather prediction and much else. For the complete space monitoring of the Ukraine it is necessary that the photographs carry multisided information on the geoecological state both of its territory and the territories of other countries. The members of the Scientific Council for Study of Natural Resources by Remote Methods, Ukrainian Academy of Sciences, are dreaming of the implementation of such a project.

Right now, however, as reported by V. Lyalko, specialists on remote sensing of the Earth have gone further. A survey from a satellite, even our own, is still not enough. In order to have complete information it is necessary to establish a network of surface stations for the reception and processing information because geoecological conditions constantly change. Accordingly, within the framework of the national space program five centers are being established, each of which will carry its own functional load. The developers were supported by the government of the Ukraine, purchasing and distributing modern computers and processing equipment to the centers. Surface stations have received the capability, for the time being in research and experimental modes, for testing space information processing methods. The work is held back by the fact that it is necessary to "hire" satellites from Russia and the United States and these services are expensive. But in the future, when the "surface-space-surface" ring is closed, the routine information collected by the "Sich" satellite will certainly become as necessary as statistics. The developers, like all the people, are dreaming and ideally see a picture such as this: at each oblast center (initially, but later in a still denser network) there will be a display from which specialists will receive not only necessary information on the geoecological state of the region, but also recommendations on the adoption of decisions in the case of accidents, calamitous events, etc.

For the time being the project can be carried out only to the extent that funding or the availability of a material base allows. However, foreign countries also are highly interested in these "scraps." Professor Lyalko stated that fairly good cooperation is being organized with American and French specialists and the Arab countries, for example, have been interested in the end product of routine remote sensing. Israel would not mind receiving assistance from the Ukrainians in the search for deep (up to 100 meters) water. To put it briefly, cash on the barrel head is being asked. It remains to get it, that is, for developing and introducing unprecedented technology.

However, the mastery of space by oneself is an expensive and slow business. The cooperation of countries here has very good possibilities. Understanding this, specialists at the Center for Aerospace Study of the Earth are striving to organize mutually advantageous contacts with Russia and other foreign partners. Together with Russian colleagues and with the participation of scientists in the United States and ten other countries in the world the Ukrainians are working on the implementation of the very interesting "Priroda" project. It provides that in late 1994-early 1995 a module with the most modern and perfected instrumentation will be constructed which will link up with the Mir orbital station and with which with time a solution will be found for mankind's problems of space monitoring of the Earth.

## Belarus Continuing Work in Space Sector

*947Q0065A Moscow POISK in Russian No 51, 30 Dec 93 p 13*

[Article by Olga Tomashevskaya: "Will Space Yield Dividends?"]

[Text] Space research in Belarus is under the direction of the Technical Cybernetics Institute, Belarus Academy of Sciences. At first glance at the interior of the institute you feel a slight disenchantment: the old walls and the decrepit furniture have nothing in common with those nickel-plated, shiny Hollywood surroundings which you involuntarily visualize when the word "space" is mentioned. However, one should not be surprised by the fact that heroic figures in spacesuits are not strolling along the corridors of the institute in spacesuits, but by the fact that Belarus space has received state funding at all. This happened this autumn. The first funds, allocated by the Belarus government for four months of research, by space standards was modest: 350 million rubles.

Boris Beregov, the deputy director of the institute, chairman of the republic Space Council, had few hopes for that. This, to be sure, has not been reflected in that uncommon stubbornness with which he has confronted all possible government agencies, striving to obtain support for the ill-understood, costly and little-profitable program. Under the conditions prevailing in impoverished Belarus Boris Beregov achieved the most significant miracle.

Despite the existence of a republic council, for the time being there is neither a centralized leadership nor a uniform clear-cut program for the several institutes, enterprises and laboratories working in this field. They all, independently of one another, are engaged in development work, approximately half of which is for the needs of the republic and half for participation in the CIS intergovernmental program for investigation and use of space.

The Soviet Union and Europe have carried out parallel military development work which later, also in a parallel fashion, has experienced conversion. As a result, in some respects our level was higher, in other respects that of the

West was, but neither Europe nor America in the immediate future will become our clients.

With respect to third countries, they (such as the recently arriving Indians) have already expressed their interest in Belarus research. However, as Beregov acknowledges, this is inadequate for the sale of our developed products—it is necessary to broaden and somehow further improve our products.

The production relationships of the countries of the former USSR, which are linked to ours, is a different matter. They have proposed the purchase of systems developed in Belarus, which are inexpensive in comparison with European products. In addition, the specialists who are installing, repairing and adjusting equipment are readily available. We, in turn, are interested in the former Soviet republics for the very same reasons. Around Beregov's desk, as in the good old days, there is a gathering of Russian, Ukrainian, Baltic, Uzbek, Turkmen and Tajik specialists.

Belarus scientists are participating in the work of the CIS Intergovernmental Space Council. Its activity is organized on the principle of the European Space Agency. All the countries participating in one project or another are contributing resources to it proportional to their gross national product. But money is not being directed to some abstract treasury, but to research in one's own territory. For example, funding was recently obtained for the work of the Institute of Heat and Mass Exchange of the Belarus Academy of Sciences for study of the thermal insulation of satellites and spaceships. Providing the Russian agency with their results, our specialists receive information on the research carried out in other countries which are members of the agency. Now there is partial funding for work on developing the MK-94 multiband camera for satellites of the Resurs system and payment is being received for work on developing special apparatus for studying the ozone layer.

And nevertheless, what reason does Belarus, with its poverty, have for spending money on space? After all, government expenditures on space research are not paying for themselves in any, even superhighly developed country of the world.

"In actuality, such research seems suspicious to all who recognize only direct profit," says B. Beregov. "They do not understand that by not sensing the Earth's surface more is lost than is saved in the funding of this work. When in the spring the Pripyat has overflowed and the Polesye has been inundated, the only thing which we could do, insofar as I know, was to go out into the disaster regions and estimate the inflicted losses. But if we had organized a systematic procedure for the collection of information from special radar satellites it would be possible to trace in advance how the water is spreading and accordingly, make predictions. Proceeding on the basis of this information, the government would take measures knowing precisely what had to be done: construct dams or dig trenches, relocate or not relocate the people."

Using satellites it is possible to predict the weather and crop yields, find minerals and evaluate ecological conditions. Incidentally, the sole space research in Belarus in which the entire world is interested is probably related to the consequences of Chernobyl. Having survived the accident, we became a unique region where it is possible to monitor the fission of radionuclides, their propagation and their effect on the environment.

"With what is space science in Belarus now occupied?"

"We have developed special system for processing the information received in sensing the Earth. After all, it is insufficient simply to have photographs in our hands. In order to assess the content of an image it is necessary to use special mathematical methods. We are buying equipment and developing mathematical methods and technologies for the processing of images and are adapting equipment for solving definite problems. We are doing all this by order either of organizations in Belarus or those countries which are interested in such work."

## Koptev Press Conference Stresses Benefits to Russia From 'Alpha' Space Station Project

*937Q0033 Moscow KOMMERSANT DAILY in Russian 17 Nov 93 p 4*

[Article by Viktor Zamyatin, under the rubric "Cooperation Between Russian and the US in Space": "Russia Intends To Work Out an Equitable Partnership"; first paragraph is source introduction]

[Text] **The Russian-American collaboration in space is gradually moving to a plane in which specific projects are being undertaken. During the U.S. visit that was wrapped up at the end of last week—a visit by the Russian Space Agency (RSA) delegation, which was headed by the agency's director, Yuriy Koptev—a detailed plan was coordinated for the creation of an international space station, which for now is being called Alpha. That plan was made public by the RSA head at a press conference yesterday, and it will go into effect after the signing of the agreement in December, when U.S. Vice President Al Gore visits Moscow. At the same time, the RSA and the American National Aeronautics and Space Administration (NASA) will conclude a similar agreement, as well as a basic contract worth $350-370 million.**

The new plan will replace two projects that existed independent of each other—the American Freedom project, which in fact was closed down because of financial difficulties, and the Russian Mir-2, which Russia, too, lacks the money to complete by itself. Mr. Koptev noted that the participation in the creation of the Alpha station will be 2- to 2.5-fold cheaper for Russia than would the Mir-2 project. The first stage alone of the creation of Alpha (in which the Russian Protons and the American Shuttles will deliver to the Mir station additional equipment, and in

which joint flights of Russians and Americans will take place) will enable Russian enterprises of the military-industrial complex to receive contracts worth $400 million. The U.S. administration has promised to allocate that money to pay for the services of Russian firms in 1995-1997. In the second and third stages (the station is to be completed by the year 2001), the RSA head estimated that the figure may grow to $900 million. The plan, signed by the heads of the RSA and NASA in Washington, has already been sent for review to Congress and to the Russian government.

Mr. Koptev brushed aside the fears that the Americans would be the proprietors of the station. Russia is contributing to the project its own technologies and services, and, in his opinion, the overall balance will be in favor of Russia. In addition, the head of the RSA is convinced that the project itself is impossible without the equal participation of Russia in the creation of the station. It's true that for now, Russia is participating in it only as a partner. The European governments, as recently as October, were reviewing the question of the equal participation of Russia—a final decision is to be issued in early December, and it is expected to be positive. Apparently, the Europeans are supported by their colleagues, the heads of the Japanese and Canadian space agencies, which, on the basis of the intergovernmental agreements of 1988 and the bilateral agreements of those agencies with NASA, are regarded as equal participants in the project for the international space station.

Russia must also resolve a number of specific questions with the European [Space] Agency regarding, for example, the flights of European astronauts on the Mir station. As for another aspect of the participation of Russia in international space programs—commercial launches of satellites—Mr. Koptev noted that there are already a number of precontract proposals—specifically, for the launch of the European satellite Astra atop the Proton launch vehicle. The Lockheed firm will handle the marketing for that.

## Cosmonaut Sevastyanov Runs for Legislature as Communist Candidate

*937Q0046 Moscow PRAVDA in Russian 11 Dec 93 p 1*

[Interview with V. I. Sevastyanov, USSR pilot-cosmonaut, twice Hero of the Soviet Union, and USSR State Prize laureate, by Valentina Nikiforova: "Once He Told a Parable"; first paragraph is source introduction]

[Text] Vitaliy Ivanovich Sevastyanov—twice Hero of the Soviet Union, USSR pilot-cosmonaut, and USSR State Prize laureate. Little mentioned, but such dear, splendid titles. And a recent title—people's deputy of Russia. And the current title—candidate for people's deputy of the Federal Assembly, and together with G. Zyuganov and V. Ilyukhin, he is heading the list of the preelection association, the Communist Party of the Russian Federation.

**PRAVDA:** Vitaliy Ivanovich, you saw with your own eyes the tragic end of the Supreme Soviet. And once again, you're going into politics. Why? Because of dissatisfaction with your personal life and your social position, or because of a desire to be high profile?

**Sevastyanov:** I'll tell you frankly: out of a sense of social responsibility. And four years ago, which I plunged into my first preelection campaign, I was doing it with that same sense. I didn't have any experience in politics, I just learned it as I went. I knew this: the most important thing is to be honest. Now after three and a half years of work in the Supreme Soviet, I feel an acute need to use the platform of the highest organ of representative authority to explain to the people where we're being taken and what lies ahead.

**PRAVDA:** You could explain without being a member of parliament. You have fame and authority.

**Sevastyanov:** But the possibilities are considerably fewer. And the main thing is that in parliament, you can have a direct effect on the fate of Russia, that is, the actual possibility of either adopting or rejecting a given law. And just look at how many harmful laws we've managed to reject! For example, when they were discussing the legislation on jurors, I told a parable. One great visionary brought to his country a sundial, and the people learned what time it was. They began to appreciate time, they worked better, and the country flourished. The people idolized the dial and decided to erect a temple to it. They raised the walls, and then imbricated the cupola. The sun went away, the shadow disappeared, and the dial didn't work. The people lost track of time and again became disorganized—devastation came, and the country fell apart.

The parable was timely. Seven percent voted for the law on jurors. There it is—with a majority you can make sensible decisions. The parliament, after all, is not simply a publicist platform—it's a platform for unification and for promoting a sense of social responsibility for the future of the country among deputies of varying political persuasion.

**PRAVDA:** What would you like to start your work in the State Duma with?

**Sevastyanov:** With a reform of the government. I don't know when the Duma is to assemble, but that has to be done right away. Second, the course of the reforms has to be adjusted in order to stabilize the economic and political situation. Otherwise, a social explosion is unavoidable. And third, perhaps, is parallel to the first two steps—restore the Fundamental Law (the Constitution) and the laws that were adopted by the Supreme Soviet. The state is the law. If there's no law, there will be repression.

**PRAVDA:** Vitaliy Ivanovich, do you still have ties with NPO Energiya?

**Sevastyanov:** Of course. I'm still in the cosmonaut corps. I work as an instructor and as an experimenter-cosmonaut. We have these slots: a plain cosmonaut, an experimenter-cosmonaut, and a researcher-cosmonaut. In terms of work experience and length of service, there are cosmonaut candidate, cosmonaut, and cosmonaut instructor. And since I've long been an experimenter in the cosmonaut corps, I hold an instructor's position.

**PRAVDA:** Has the political and economic instability also had an effect on the space program, a sector that is so favored by the public, is prestigious, and is, in fact, profitable? Has it affected the Energiya association. Or have they noted no changes there—things going the way they always did? I mean, our people are still going aloft. Could it be that the talk of difficulties is just a matter of habit, to get a little more from the state for the growth of the sector?

**Sevastyanov:** What? No changes? The funding for the space program has been cut by more than 60 percent. The funding difficulties have forced us to let go several thousand of the most skilled specialists from the enterprise.

Several thousand?

**Sevastyanov:** Yes, several thousand. In our sector, 38 percent of the candidates of science and doctors of science have been let go; they went to commercial structures or went abroad. The Mir station, which has already worked through three service lives, exists and operates to this day as a result of a colossal repair-and-restoration program. But it can't last forever. And they haven't put up a new station—there's no money. And if the funding isn't opened up in the near future, our consistent work in space will cease.

**PRAVDA:** And that's why it is with such sadness that we recall past records and feats. You, after all, went into space for the first time in 1970, right?

**Sevastyanov:** With Andriyan Nikolayev. Aboard Soyuz-9. We were aloft for 18 days. At that time, after the five-day missions, that was the first long-duration mission; it was an absolute world record for three and a half years, and, in that class of spacecraft, it is a world record to this day. The second time I went aloft was with Petr Klimuk, aboard the Soyuz-18, in 1975; we docked with the Salyut-4 orbital station. We saw the Soyuz-Apollo docking—we were 110 kilometers above them. And then we returned to the ground after them.

**PRAVDA:** You were born in the Urals and finished school in Sochi. What brought about such a change in location?

**Sevastyanov:** In December 1945, my father was demobilized, and he took me and my mother to Kuban. At first we lived in Maykop, and then in 1948 we moved to Sochi. My parents stayed there. My father died five years ago, and my mother didn't want to move away.

**PRAVDA:** Did your father ever tell you stories about the front?

**Sevastyanov:** Of course. He left on the third day. And spent the entire war in the same 150th Separate Tank Brigade of the High Command Reserve. He fought on several fronts—near Konev, near Zhukov. He finished the war in Prague.

**PRAVDA:** Did he hold a high rank?

**Sevastyanov:** He was an ordinary enlisted man—senior sergeant. He drove a tank the whole war. He had the full set of enlisted man awards. That's the history of my father and his fellow soldiers, and I won't allow it to be defiled. That's why I've volunteered to defend the CPSU in the Constitutional Court.

**PRAVDA:** Vitaliy Ivanovich, you're being asked about a lot of things in the preelection meetings. But I would like to ask about the logo of the Communist Party of the Russian Federation in the elections: a crisp, elegant drawing of the hammer and sickle is surrounded by the words "Russia. Fairness. Labor. Power to the People."

**Sevastyanov:** The person behind the logo is the science-fiction artist Andrey Sokolov. I've known him for some 25 years, since he first entered the cosmonaut corps, in which Aleksey Leonov worked. The logo is rectangular. You won't get it mixed up with any other.

## U.S. Said To Be Taking Advantage of Russia in New Space Agreements

*937Q0043 Moscow YEZHEDNEVNAYA GAZETA in Russian 8 Dec 93 p 3*

[Article by Lev Kamanin, candidate of technical sciences, docent, and instructor at the Military Air Academy imeni N. Ye. Zhukovskiy, under the rubric "Documents": "Theft in Orbit, Or How Our 'Space Achievements' Are Being Put Onto the World Market"; figure of possible configuration of international station not reproduced here]

[Text] The crisis situation in our aerospace industry, which has been cast to the whims of fate by the Russian government, is approaching a point beyond which its resurrection will, in the near future, be impossible. We're reassured by the fact that the Russian Space Agency, in attempting to avert an impending catastrophe, has managed some big successes in the commercialization of that most important sector of the military-industrial complex.

According to the American-Russian agreement that has been adopted, Russia, until the end of the century, can conclude no more than one contract a year for the launch of geostationary satellites, whereas contracts for the launch of low-orbit satellites must be examined on a case-by-case basis. U.S. businessmen are taking care of Russia's revenues: the payout for each commercial launch of the Proton vehicle cannot be lower than 92.5

percent of the price asked for similar launches by U.S. or Western European companies.

U.S. congressmen and representatives are playing the role of "good patrons," supposedly defending Russian interests against the encroachments of the "bad Western European merchants." The latter guys, of course, are not ecstatic about the attempts of the "Russian agency" to enter the "trade ranks" on the world space market. But the Americans, in turn, are concerned about the considerable share held by Western Europe in the revenues from commercial launches of satellites, while, in their view, their own share is small (at 35 percent). That is why the United States is striving to dictate its own strict requirements for the conclusion of trade deals to its new competitors, as well as to its old competitors. Assistant U.S. Commissioner for Trade Peter Olzier [Olzhiyer] declared this: "Representatives of Western Europe are trying to coordinate an agreement that determines such rules (essentially, fettering for Russia and other potential competitors—L. Kaminin), with simplification of the procedure for producing with them sanctions of the American government against launches."

What kinds of revenues are stipulated for us in that agreement? Russian Space Agency director Yuriy Koptev says that participation in commercial launches of launch vehicles and the sale of aerospace hardware will being Russia no less than $200-220 million a year. Is that a lot? We know that in 1992, the worldwide total for revenues from the commercial use of space hardware reached $13.2 billion. With that, the revenues from the use of launchers did not exceed $1.2 billion, that is, 10 percent of the total revenues. That means that the country that was the first to open the path to space will be allowed to receive for offering its launchers no more than one-sixtieth of the worldwide total of "space revenues." And that until the end of the century.

Against the backdrop of that "space theft" announced beforehand, the ultimatum presented by the United States to Russia in connection with the contract concluded in 1991 for the delivery to India of cryogenic motors for a measly $2 million simply pales. And yet it is in force. True, that was only after, in exchange for refusing the little blue bird in the hand—the agreement to "freeze" the contract with India—they promised us the crane in the sky: they promised to better the chances of Russia to participate in the building of the Freedom orbital station.

President Clinton approved a limit of $10.5 billion for the spending associated with the creation of the Freedom station up to the end of the 20th century. Russian Prime Minister V. Chernomyrdin, as he was departing recently for talks in the United States, announced that the participation of Russia in the realization of the Freedom project will enable the Americans to "earn" more than $2 billion. The prime minister was modestly quiet about how much we would earn. Either he was hiding that intentionally, or he didn't know what we would earn.

But in the words of Yu. Koptev, we will be paid $600-700 million for the help Russia will give the United States in building the station. We should note that if a joint three-way project is adopted, a good half of the station modules will be units being developed for our future Mir-2 station, whereas the American laboratory will take up no more than one-fourth of the total space of the structure.

Why, we ask, do we place such a low price on our labor and our scientific and technical achievements? After all, the minimum cost of the American "quarter" of the future station is estimated by U.S. specialists to be $10.5 billion, whereas the Russian "half," if we are to believe our prime minister, is only $2 billion, which is saved by the Americans as a result of the use of Mir-2 units. And why, if we are to believe Mr. Koptev, will we be able to get only a third of that clearly understated amount?

You arrive at some uncomfortable conclusions. Neither the Western European wholesale space merchants, nor our transoceanic patrons are really burning with the desire to have another competitor on the "free and uncontrolled" market for space technologies and services. And that's why, in the discussion of joint plans and programs of cooperation in space, they're addressing us not as equal partners, but as poor relatives patiently awaiting the next pittance from a bar stool.

## Commercial, Conversion Activities at TsAGI

*937Q0042A Moscow NEZAVISIMAYA GAZETA in Russian 30 Nov 93 p 6*

[Article by M. Kalashnikova, under the rubric "Anniversary": "Dreaming About the High Heavens, TsAGI Is Busy Making Its Own Boots"]

[Text] Throughout its entire 75-year history, the N. Ye. Zhukovskiy Central Aerohydrodynamic Institute (TsAGI)—the leader and head institute of domestic aircraft building—has been proud of its contribution to "everything that flies in the skies over our country." Today, it is concerned with its needs on the ground.

Things are not easy in the current conditions for the one who for so long was the country's favorite brainchild, to whom nothing was refused, and whose requests were a top priority. In the years of shortages, lines, and product cards, Zhukovskiy's aviation center was in no need "in the field" or at home. Now TsAGI is learning not only to count money, but also to earn it.

Before, fundamental scientific advances, high-tech aerospace hardware, and defense products were fully ordered, financed, and used by the state. Now, in crisis conditions, the state accounts for only 40 percent of the TsAGI budget. The actual situation, in the estimation of TsAGI director German Zagaynov, is that, in the near future, society will be unable to support a considerable portion of the intellectual potential and high-tech research that have been accumulated.

The problem is not just in the expensiveness of a commodity whose affordability is limited to only the state or, in the extreme, large firms who need the product. TsAGI's misfortune is that it used to be far in the lead in the technical standards of our society, which is still incapable of making skillful and full use of the scientific-technical wealth created in the institute. The institute has to survive on its own: the state hasn't proposed any special conversion programs or any policy stimulating internal or foreign investment to support basic research.

With Russian partners, TsAGI has built and is the proprietor of a factory that has already begun series manufacture of ... men's and women's shoes. All the staff members of the institute will, within a year, be shoed in boots of their own making. Other commercial enterprises that have been created at TsAGI and that produce metal tiles, lining panels, mixers, ceramic dishes, lamps, wood-drying chambers, etc., are also operating successfully.

A special commercial-conversion service has been created in the institute to coordinate the new types of activity. It organizes investment and holding companies and institute banks and insurance structures; it sets up shareholding; and it is involved in privatization. The funds attracted in connection with contracts with domestic industry represents 27-30 percent of the institute's budget today.

TsAGI's commercial activity is not just a means of becoming independent in the absence of the customary trusteeship of the state. It is a means of saving its unique personnel from being sold off as state orders are cut back and wages drop to low levels (they are more than twofold lower than the average in the country). Overall, over 5-6 years, up to 30 percent of the institute's staff members are expected to be hired by contract. The fall of 1993 saw the introduction of a system of grants for young specialists who are developing promising advances, wages increases of 30,000 to 50,000 rubles [R] for those who enter master's programs, and awards of a half a million rubles for who defend their dissertation.

In the opinion of German Zagaynov, to survive, the economy today needs "monsters"—powerful multiprofile, multifunctional corporations capable of combining science and applications, i.e., basic advances, experimentation, and production. That is why, at the initiative of TsAGI, the Association of Aerospace Enterprises and Institutions of the Southeastern region of Moscow Oblast was formed in October of this year. The operating program of that consortium involves not only conversion measures capable of creating and maintaining new markets, but also the solution of a long-existing, painful problem—how to raise the standards of production rapidly.

The initiators of the project feel that it can become a fragment of the scientific-industrial policy of Russia and that it will at the same time make it possible for the institute to "become integrated into the region, work for it, and get results from the region." There is a hope that the regional corporation will help to develop and transform for the internal and external market TsAGI's high-level technologies, which, in return, will give to the institute its former high professional standing and to Russia, an economic dynamism, a high standard of living, and prestige in the world.

## NASA Signs MOU on Cooperation With TsAGI

*937Q0042B Moscow SEGODNYA in Russian 7 Dec 93 p 3*

[Article by M. Kalashnikova, under the rubric "Partners": "TsAGI and NASA Have Signed a Memorandum on Cooperation: The American Side Is Interested in the Russian Intellect and Technologies"]

[Text] A delegation of the National Aeronautics and Space Administration (NASA) visited Moscow for a working meeting with officials of the Central Aerohydrodynamic Institute (TsAGI) and in connection with the anniversary celebrated by its TsAGI colleagues. The head of the delegation, Wesley Harris—the deputy director of NASA—is the immediate head of all four of its research centers. The intensive two-day talks between Harris and the deputy chairman of the State Committee on Defense Sectors of Industry of Russia, Anatoliy Bratukhin, resulted in a memorandum on cooperation between Russia and the United States in the field of basic aviation research.

The document is to serve as one of the appendices in an agreement on cooperation between Russia and the United States that is supposed to be signed on 16 December 1993 at a meeting between Vice President Albert Gore and Prime Minister Viktor Chernomyrdin. On behalf of the Russian government, the appendix will be countersigned by the chairman of the State Committee on Defense Sectors of Industry, Viktor Glukhikh. The document is to expand the possibilities for joint work that were alluded to in the August agreement on cooperation in space.

It will be primarily TsAGI and the Central Institute of Aviation Materials (VIAM) that will actively interact with NASA on the research program outlined.

The American partners are interested primarily in the Russian intellectual potential, our methods of basic research, and a number of "high-level technologies" that, in the United States, are less effective or don't exist at all.

For TsAGI, in the words of its director, German Zagaynov, the signing of the agreement during the anniversary was profoundly symbolic—the document was initialed in the same room in which A. N. Tupolev designed his first airplanes.

## Work Proceeding on Papua-New Guinea Spaceport Project

*947Q0045A Moscow FINANSOVYYE IZVESTIYA in Russian No 59, 17-23 Dec 93 p 8*

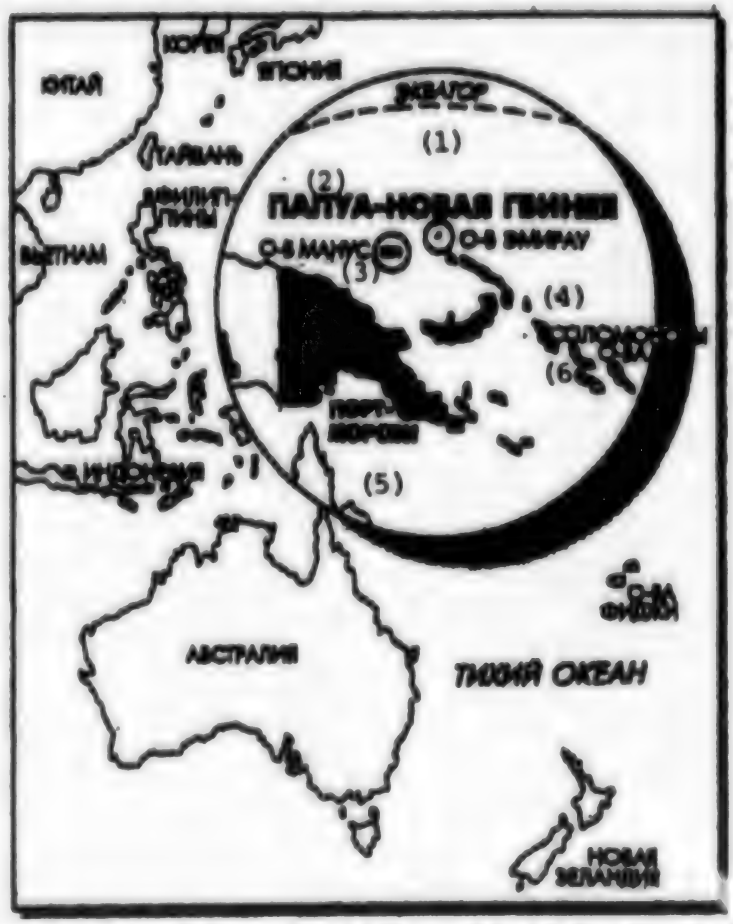
[Article by Petr Yevseyev, FINANSOVYYE IZVESTIYA correspondent: "International Spaceport Uses Russian Technology"]

[Text] Russian space industry is receiving a chance for strengthening its positions in the world and broadening its share in the commercial launches market. The directors of the key enterprises of the national space complex in November were familiarized with the sites of the proposed construction of a new international privately operated spaceport. It will be located on one of the islands of Papua-New Guinea and Russian specialists will play the leading role in its construction.

The idea of establishing a spaceport arose in Australia and initially its construction was proposed precisely there, on Cape York. However, in the course of elaborating the project the Space Transportation Systems (STS) concern, organized for this purpose, came to the conclusion that it was more feasible to construct it in Papua-New Guinea. The islands proposed by the government of this country are closer to the equator (Emirau Island—1 degree 40 minutes from the equator, Manus Island—2 degrees) and make it possible to increase the mass of the payload put into a geostationary orbit by a Proton booster by more than double.

In March five of our enterprises signed a preliminary agreement with the STS. The Australians are taking upon themselves the concerns about the financing of the project and construction, together with Papua-New Guinea, of the infrastructures of the future spaceport. Our task is supplying technological equipment for the spaceport and the performance of the principal assembly work.

Five years ago, when the idea of the construction had just come up, American, French and British companies offered their services. However, Russia was selected as the principal partner and the Zenit first, and then the Proton, was selected as the basic booster. Nikolay Pismennyy, department head at the Main Administration for Rocket and Space Technology of the State Committee for Industrial Defense Branches, attributes such a choice to the fact that the Proton is now the most reliable




Key: 1. Equator 2. Papua-New Guinea 3. Manus Island 4. Emirau Island 5. Port Moresby 6. Solomon Islands

and has the greatest capabilities of any rocket in the world. This booster has been launched more than 200 times.

Under the agreement, by the end of the first half-year of 1994 the Design Bureau for General Machine Building, with the participation of other Russian enterprises, should have developed a rough draft of the spaceport. It is proposed that the first launch of a booster from the new spaceport will take place in 1998.

The work done by our companies will be paid for at once, regardless of the further operation of the constructed spaceport. According to preliminary estimates, the cost of the spaceport will be from 900 million to 1 billion dollars. Half will be the cost of the technological equipment and half will be the cost of construction. Thus, the cost of deliveries of equipment and one technological booster will be from 400 to 500 million dollars.

But Aleksey Krysanov, department head at the Design Bureau for General Machine Building, feels that the profit from these deliveries will be small, so that the preservation of jobs at production plants will be the most significant attainment. The principal income for Russian enterprises, which will probably be combined into some consortium, such as the Australians have, will come from subsequent sale of Proton boosters for launches from the new spaceport.

In addition, the Australians propose and even insist on our participation in its subsequent operation. And they propose that the Russian side become a co-owner of the spaceport, which will make it possible to obtain a profit not only from the sale of boosters, but also from the results of its commercial use. Our contribution to the international consortium will be in the form of "know-how."

However, the scales of the project and the intensification of the project during its realization, even without the stiff competition in the world commercial launches market, do not make it possible to consider the construction of the new privately operated spaceport in Papua New Guinea to be an already accomplished fact. It is sufficient to recall the experience of such cooperation between Russia and Brazil, where all work ceased due to pressure from the American side.

## Disadvantages to Russia Seen in 'Alpha' Space Station Project

*947Q0037A Moscow SEGODNYA in Russian 25 Nov 93 p 8*

[Article by Mikhail Chernyshov: "Mir + Freedom = Alpha. The Americans Pay and Profit"]

[Text] In the middle of December Russian prime minister Viktor Chernomyrdin and American vice president Albert Gore most likely will sign an agreement on the construction of an international space station.

The two countries for a long time and with great efforts went as far as they could go to acquire absolute supremacy in the manned space sphere. As a result, Russia will not have a new gigantic Mir and the United States will not begin construction on the Freedom station. But nevertheless an intricate structure designated Alpha will appear in orbit. This orbital complex will be a "cluster" of several laboratory modules. In addition to Russia and the United States, Western Europe, Japan and Canada are participating in the project. The cooperating participants assume that with minimum financial expenditures—due to the sharing of expenses—each will have the opportunity to carry out research in a unique celestial center outfitted with the most modern technology.

In the first stage the technique for joint flights is being perfected and the capabilities of the vehicles developed for the project are being clarified.

In the two subsequent stages work will begin on station assembly. It will be made up of living and specialized modules, solar panels of enormous area and docking units making it possible to dock ships of different types (Soyuz, Progress and Shuttle) to the orbital scientific research institute. If everything goes OK, by the beginning of the coming century the international station will constitute a permanently operating orbital structure designed for six researchers. The useful volume of the living and research compartments is 1200 cubic meters and the electric power produced by the sources is 120 kW.

At first glance the project is attractive. In the opinion of Yuriy Koptev, director of the Russian Space Agency, station Alpha is much like a straw which by grasping Russian manned cosmonautics will be able to survive. His optimism is attributable to the fact that in the first stage the United States intends to spend 400 million dollars on the project. A large part of this money will go for paying for the services of Russia, because this stage involves the intensive use of elements of Russian rocket and space technology.

To be sure, there also must be an increase in allocations "for space" from the Russian federal budget.

For the sake of correctness it must be noted at once that this project has not only its vigorous proponents, but also not less equally opinionated opponents. This applies to virtually all the participating countries.

Not so long ago the NEW YORK TIMES published interesting calculations applying to the American space program. They indicate that NASA is still receiving considerable funding from the federal budget: over 14 billion dollars annually. Much of this sum will go for the construction of an orbital station and flights of multiply reusable ships. But these two cost items have recently been those most severely cut back. Private space business, already today, incidentally, earning good money, has moved to the forefront. According to an estimate of the American Department of Commerce, five billion

dollars of profit were earned in this sphere during last year. Most of the income has been from communication satellites and space information used in environmental research.

The largest commercial project is now considered to be the Iridium project, carried out by Motorola. Its cost is three billion dollars. By the end of the century several tens of satellites of this system will provide clients with wireless telephonic communication with any point on the planet. NASA is not participating in the project, but the Russian enterprise Khrunichev is involved, to be sure, with a very modest role. In general, however, the very fact of financing of such a large-scale scheme completely with private capital, in the opinion of analysts, definitely indicates that there have been fundamental changes in approaches to space in the United States.

In Russia there has been a strong outflow of personnel. The branch has aged in a blink: those have remained who have no place to go. The production of many components of rocket-space equipment without which the implementation of long-term space programs is impossible has been put on the shelf.

Viktor Chernomyrdin visited the Flight Control Center at Kaliningrad, near Moscow. He advised a "downsizing." However, now at the very top, according to Mr. Koptev, proposals have been made which should fundamentally improve the situation in the branch. The wage is being increased eightfold in comparison with the present-day minimum. Provision also is being made for a number of other payments. Alas, even with such a sharp "jump" in wages the salary will remain much lower than the earnings not only of people from commercial organizations, but even workers in many ordinary production fields. But as long as the stage of regularization continues, inflation will succeed in reducing everything to the former level.

In order for Russia to participate in the Alpha project it will be necessary to restore connections among tens of enterprises not only in Russia, but also in nearby foreign countries. That is, return to the same circles from which we just emerged. How much will participation in the project cost Russia? No one knows the answer. But it is clear that this will be hundreds and hundreds of billions of rubles.

Western participants see in the project a sort of locomotive which will favor further advance in many branches of science and technology: medicine, biology, materials science and use of the environment. Will Russia be able to use space attainments as effectively as our partners? All earlier experience in national cosmonautics forces us to doubt this. Just consider space environmental science. It earlier remained a "thing unto itself." Now environmental surveys, if we speak of the territory of Russia, are becoming virtually impossible.

Alpha will be put into an orbit with an inclination of approximately 52 degrees, traditional for our stations. It is advantageous from the energetics point of view, but the northern territories will not fall in the station field of view. Earlier we settled for this: nevertheless the most populated southern part of the USSR was clearly observable. Now from aboard the station it will be possible to observe only 7% of the territory of Russia.

## Former IKI Director Sagdeyev Comments on Russian Space Program

*947Q0036A Moscow MOSKOVSKIYE NOVOSTI in Russian No 48, 28 Nov 93 p 9*

[Interview between Yuriy Sigov, MOSKOVSKIYE NOVOSTI correspondent, and Academician Roald Sagdeyev, at College Park, Maryland, date not given: "Did Russia Sell Out to the United States"; the first paragraph is an introduction]

[Text] Academician Roald Sagdeyev scarcely requires introductions. For many long years he was the leader of space science in the USSR and was at the center of development in our country of the most modern types of rocket technologies. Now Roald Sagdeyev is an honorary professor in the Physics Department of the University of Maryland and is living and working in the United States. We asked him to evaluate the present-day status of Russian-American space and rocket cooperation.

**Sigov:** Over the course of many years the USSR and the United States actively cooperated in the cosmonautics field. How are these relationships developing now?

**Sagdeyev:** The breakup of the USSR also had a negative effect on the development of space science in our country. The number of launches has been reduced to one-third and there are neither workers or clients for space programs. The political stimulus also has fallen away: it is clearly unrealistic to participate in a space race with America in order to prove the superiority of our social system.

Cooperation with the United States is today helping Russia, in a time difficult for our country, to maintain its positions in the world market in those sectors where for the time being they are still strong: in rocket construction and cosmonautics. However, mere programs for space cooperation with America will not sa e us. The Americans have cooperated in only a few programs, which cannot begin to cover even a small part of the capabilities of our space complex.

With respect to Russia's use of its commercial potential in the space field, the demand for such services in the world market is now shrinking. For Russia, even now under the pressure of the leading world space powers, quotas have been set which simply cannot be changed. Precisely for this reason the contacts between NASA and the Russian Space Agency (RSA) and the creation of a unique Russian-American space station, which may carry our cooperation to new limits, are encouraging.

**Sigov:** Russian opponents of cooperation between NASA and the RSA say that we seem to be selling our leading space technologies to America for a pittance. Is this actually the case?

**Sagdeyev:** To think that America is buying us for a pinch of snuff is oversimplified and erroneous. It is impossible to give America things free—that is opposed by the American aerospace business, which in the case of Russian dumping loses its own orders. It was precisely American companies which were successful in setting quotas for Russia in order not to allow inexpensive Russian space technologies on the world market.

**Sigov:** It is assumed that under pressure from the United States Russia has reexamined or frozen many of its projects with other countries. In this sphere to what degree is Moscow actually dependent on Washington?

**Sagdeyev:** I feel that there is no political pressure by the United States on Russia along these lines. To be sure, there is the form of conclusion of exclusive deals between companies in the two countries from which Russia, when something is disadvantageous to it, has the right to refuse. However, there also are extremely advantageous proposals. For example, a joint enterprise was recently established with the participation of Russian, American and French companies for the development, sale and production of a new generation of plasma engines.

Such contracts will help Russia to enter the world market with the minimum losses to it. But at the same time Russia today is simply obligated to cooperate with the United States also in another direction—nonproliferation of rocket technologies, especially those which can be used for military purposes. Precisely this cooperation also in the last analysis exerted an influence on the fate of the Russian-Indian contract for cryogenic engines.

**Sigov:** Did not Moscow sell out by breaking the extremely advantageous contract with Delhi and how, in general, will such Russian behavior be interpreted in other "third world" countries desiring to cooperate with Russia?

**Sagdeyev:** With respect to the Indian contract there was no simple and unambiguous solution. In Moscow, evidently, it was decided that in comparison with the "friendship of a friend" (with India), the principles (nonproliferation of rocket technologies) were more precious. International strategic stability also is preserved due to these principles.

Unfortunately, the protocol on the nonproliferation of rocket technologies was signed by the seven leading world powers, but Russia was not among its initiators, although we had a moral right to this as the homeland of cosmonautics.

In the case of the Indian contract I feel that Moscow acted correctly, although that type of cryogenic engines which we promised India is too exotic for real application in military technology. It also is necessary to take into account the fact that at the height of the debates on the contract India, with the assistance of France, launched its own communication satellite, letting it be understood thereby that it had no intention to be oriented only on Russia in space cooperation.

Looking at this example, the countries of the "third world," potential clients of Russia, wishing to receive its rocket technologies for use for military purposes, probably have been frightened away, which is good. But since in Russia there is much which can be proposed for the world market other than cryogenic engines, there will be no shortage of customers. For example, plans are now being made for a deal between Russia and China for the sale of our rocket technologies to them.

**Sigov:** And what other countries are showing an interest in Russian rocket technology?

**Sagdeyev:** There is now an oversupply of space services on the world market. Russia, the United States and France scarcely will allow newcomers from the "third world" to enter this market. In addition, as experience shows, these countries are striving to acquire specifically military rocket technologies (China, Iran, Iraq, and to a lesser degree Argentina and Brazil). They all have their national rocket-space programs and may potentially be interested in broad-scale cooperation with Russia.

**Sigov:** How necessary, in general, are large-scale space projects with foreign partners to Russia when the economy is in crisis and there is insufficient money even for the most insistent needs?

**Sagdeyev:** Today Russia does not have its own resources, nor customers abroad, which could "feed" our space complex even equal to a third of the former capabilities of the USSR. But the creation of a joint orbital station with the United States may assist in solving some problems.

**Sigov:** What is the attitude in the United States toward space cooperation with Russia? Insofar as I know, many American congressmen have an extremely skeptical attitude toward it...

**Sagdeyev:** For the time being there is no unanimity of opinion with respect to space cooperation with Russia. NASA directors feel that cooperation with Moscow is advantageous and necessary (although there also is criticism there of such a partnership). The White House also is supporting the idea of cooperation with Russia in space. At the present time NASA has no other recourse than cooperation with Russia.

With respect to congress, senators are speaking out who fear that cooperation with the Russians will result in a loss of jobs and orders for American aerospace complex enterprises. But the Americans, I repeat, have no alternative (and they understand this): either there will be a station with the Russians or there will no station at all.

In America there is also the fear that long-term cooperation in the space sphere with Russia may become a pawn of political instability in our country. But in any case this cooperation is not only advantageous to both countries, but also is in the interests of world science.

Can Russia fully participate in this cooperation with America when in our country there are many plants on the verge of closing, state orders are being lost and functioning of the Baykonur cosmodrome is being threatened? I believe that the revitalization of our space complex is a matter of honor for both the government and each of us individually. Now there is no longer need for lofty slogans, but specific actions.

**Sigov:** On what, in our opinion, should the Russian leadership be oriented: on commercial gain from the development of space and rocket technology or on obtaining political dividends in the international arena?

**Sagdeyev:** In my opinion these concepts are inseparable. Without effective agreements making it possible to exercise control over rocket technologies it is difficult to cooperate with the civilized world. But it also is necessary to take into account the difficult economic situation in which Russia finds itself and therefore where this is possible it also necessary to fight for foreign exchange.

The strengthening of the positions of Russia in the world space market requires close cooperation of all our concerned departments—diplomats, rocket builders, scientists and practical workers. Only in such a way will we not only be able to maintain already existing positions, but also to reach new limits of space partnership with the leading world powers.

Postscript. The interview with Academician Roald Sagdeyev scarcely is the last word in the discussion of priorities of Russian rocket-space diplomacy. In any case the agreements signed in the United States on the joint development of the orbital station Alpha (successor of the Freedom station, which is not to be) give no basis for such an unchallenged evaluation. The contribution of Russia to the Alpha project is virtually everything which has been developed for the Russian Mir-2 station and all this work has cost us a sum far greater than the 400 million dollars allocated by the American side for three years. If we ourselves are not going for manned cosmonautics, why then should we continue this work no longer for ourselves, but for others?

## RSA Director, Ministry of Defense Request Special Funding for Space Sector

*947Q0035A Moscow MOSKOVSKIYE NOVOSTI in Russian No 47, 21 Nov 93 p 2*

[Unsigned article: "Cosmonautics in a Beggar's Orbit"; the first paragraph is an introduction]

[Text] The Ministry of Defense and the Russian Space Agency have sent to the government a draft decree of the Council of Ministers entitled "Measures for State Support of Russian Space Activity and Maintenance of the National Rocket and Space Industry."

The document is a reaction of the two departments to the promise of Viktor Chernomyrdin to provide government support to "Russian space," which he made during a visit to the NPO Energiya. The draft decree proposes the allocation to the Ministry of Defense of 120 billion rubles for settling debts and paying for standard deliveries for space hardware, scientific research and experimental-design work...

It is noteworthy that in the indicated paper provision is made for so- called "selective" state support. Seven enterprises which are participating directly in the production of Russian boosters, the most competitive in the world market, are receiving preferential credits. However, observers note that the government is considerably watering down the draft decree and it is significantly reducing the credits. If this happens, Russian cosmonautics will remain in an orbit of a beggarly existence. The plan for creating (on the basis of key space enterprises) corporations capable of realizing high-technology development work in such important branches as electronics, instrument making, high-speed railroad transport, aircraft construction, etc. is collapsing. The Ministry of Defense cannot update space systems for early warning of nuclear attack, satellites for the monitoring of the movement of armed forces and space communications, which to a high degree have been degraded.

Experts feel that this sort of economy (120 billion rubles are needed in space; 100 billion were spent on reconstruction of the "White House") may finally destroy the space production branch.

## Russian Role in International Space Station Project Assessed Favorably

*937Q0039 Moscow PRAVDA in Russian 10 Dec 93 p 4*

[Article by Anatoliy Pokrovskiy: "What Will It Be Called Now? Three Continents Are Slated To Meet in Orbit"]

[Text] With complicated configuration and a complex fate, this international space station has gone through the fundamental design studies, but still hasn't gotten a name. Either it will be Alpha the first letter of the Greek alphabet—to mark the first step in that direction, or it will be Sigma, a symbol of integration, or it will be something else. God only knows what will happen and what the name will be. What is much more important is that the project opens new prospects for the development of a world space program.

It was several years ago that Academician Boris Raushenbakh, one of the participants in the founding of the our space program, observed that the romantic period of its development, when every new step in near-Earth space was taken with enthusiasm and with not always well-founded hope, has ended. The time has come when any

and all of the multitude of space projects are assessed soberly and in a businesslike manner.

And recently, the current director of the Russian Space Agency, Yuriy Koptev, sighed heavily about that same period of "romantic dreams":

"Do you know the most horrible sin that a space firm could have committed back then? To not use up by the end of the year all the monies allocated to it."

Koptev's sighs are understandable to any Russian. What is more surprising is that sighs no less heavy are emanating from across the ocean. America's NASA, after calculating the prospects of the operation of long-duration orbital stations—and that includes on the basis of our Mir—clearly couldn't manage the development of its own Freedom station within the time and monetary constraints set by Congress.

Then the Alpha project appeared.

What does it consist of? Briefly put, in the conditions that exist today, it is best to design and build a permanently inhabited international space station with an inclination of 51.6°, i.e., with the same inclination at which Mir is now flying. The same stock of completed research gathered in our country for the Mir-2 will be used for the station, as well as the American, European, and Japanese modules.

The first stage of this grandiose program calls for the joint work of crews from Russia and the United States on the Mir station and the Space Shuttle. Missions of the American shuttles to the Russian station will begin in 1995 and will be used for outfitting Mir with equipment that will include solar arrays that are more productive. The Russian party will supplement the station with the Spektr and Priroda modules, which will house, in addition to our equipment, two and a half tons of American instruments.

Some $370 million have already been allocated for that, and the financing will begin this coming year. Thus, in addition to expanding the research possibilities of the station, valuable experience will be garnered for creating and using the new international space facility.

The second stage, which begins in mid-1997, will involve the startup of the assembly of the station out of individual units, including the American living module and our towcraft, which will be put into orbit by the Shuttles and the Protons. And finally, in 1998, the complex will grow with a European and a Japanese module and three more Russian modules. The station will function for 10-15 years.

"And what will the average taxpayer get out of all that?" our journalists love to ask, following the Western example. Let's discuss it the way they do in the West. For a start, our space firms, which have absorbed the intellectual and technical flowering of Russia, will get guaranteed contracts, and that means that jobs and "brains" will be kept. Just what the intellectual wealth is, is indicated directly by the example of the birth of the international space station project. The Russian experience in the operation of long-duration orbital facilities in this case have made it possible, in the estimates of specialists, to shorten building the station by three to three and a half years and cut expenses considerably. Consequently, even if they wanted to (and that desire exists among some of our rivals), they couldn't get along without Russia on the world space market.

Generally, we need to give proper due, it seems to me, to the skillful commercial policy of the Russian Space Agency. Step by step, systematically, it is getting around the obstacles that—both officially by the COCOM ban and, so to speak, quietly—are being placed in the path of getting our hardware to the market. One after another, individual agreements are being arranged for the use of the Protons to launch a number of satellites and for the creation in Papua New Guinea of a launch facility for commercial launches. And now the project for the international space station, more than anything else, is providing for the conclusion of such a political agreement with Russia (most likely during the forthcoming visit of U.S. Vice President Gore), which will open the road to Russia to a full-fledged partnership.

That is especially needed now, when the space program is, more and more, turning to us not its "celestial" [illegible], but its "early" [illegible]. It's no secret to anyone that the Earth is ill. It's ill with civilization, as a child is with chickenpox. The abscesses of the industrial megalopolises are spread across the body of the planet, poisoning it with industrial waste, polluting its water and air, reducing its forests and making its soil barren, thinning the ozone layer, and changing the gene pool. All those attacks can be seen best from space. And in space, the antidotes to them can be made. Already planned is the production there of biomedical preparations, the growth of especially pure semiconductors, and the conversion of solar energy into electrical energy. Much can be found there by the researchers from the various countries gathering in orbit in the name of our common cradle.

# END OF FICHE

# DATE FILMED

19 APR 1994